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PHYSICS ABSTRACTS

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SCIENCE ABSTRACTS

SECTION A, PHYSICS

SECTION B, ELECTRICAL ENGINEERING

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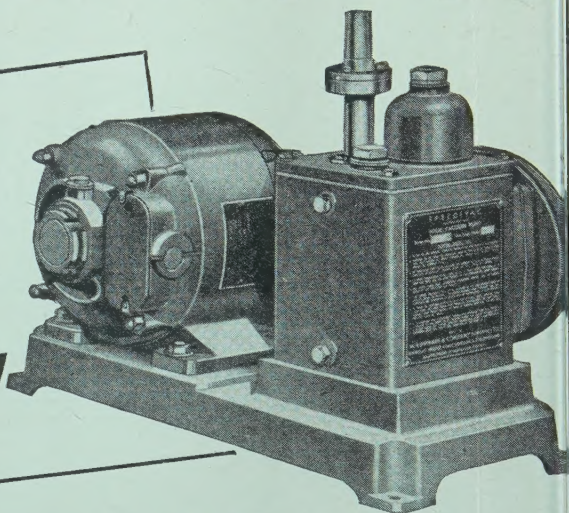
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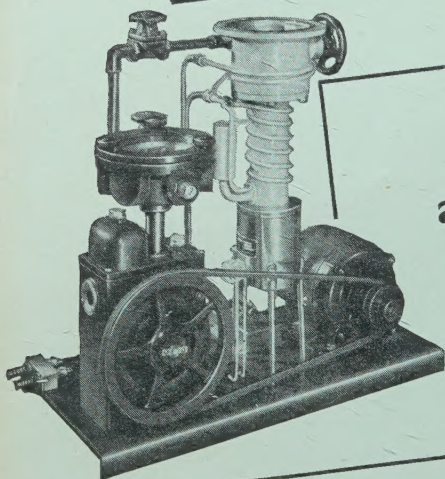
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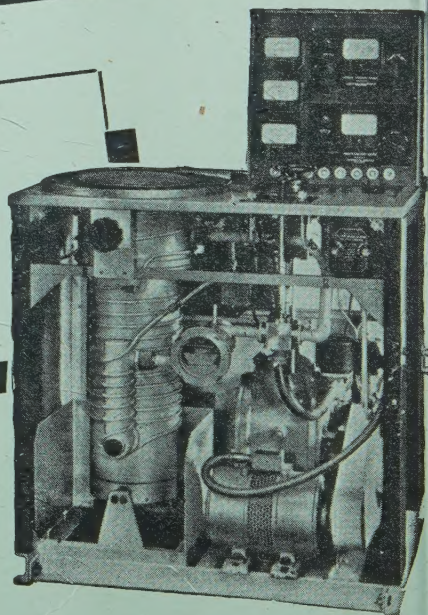


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Electrical and magnetic measurements and instruments	Thermionic tubes	Illumination
	Cathode-ray tubes	Metallurgy
Electronic relays and counters	X-ray tubes	

LIST OF JOURNALS

The following list supplements the List of Journals published with the January number of Volume 53 (1950) and the Supplement published with the Index to Volume 53 (1950). Reprints of the List of Journals (1950) and the Supplement (1950) can be obtained from The Institution of Electrical Engineers, Savoy Place, London, W.C.2, price 2s. post free.

The addresses given are believed to be correct at the date of publication, but no responsibility can be accepted for errors.

Journals marked * are not received regularly.

* <i>Acta Chem. Fenn.</i>	<i>Acta Chemica Fennica.</i> [See under <i>Suomen Kemistilehti.</i>]
<i>Acta Phys. Hungarica</i>	<i>Acta Physica Hungarica.</i> [Formerly <i>Hungarica Acta Physica.</i>]
<i>AEG Mitt.</i>	<i>AEG Mitteilungen.</i> Hohenzollerndamm 150, Berlin-Grünewald.
* <i>Ann. Mat. Pura Appl.</i>	<i>Annali di Matematica Pura ed Applicata.</i> [Abstracted by <i>Mathematical Reviews.</i>]
* <i>Beih. angew. Chem. u. Chem.-Ingen.-Tech.</i>	<i>Beihefte zur angewandte Chemie und Chemie-Ingenieur-Technik.</i> Verlag Chemie, Weinheim/Bergstrasse.
* <i>Commun. Dublin Inst. Adv. Stud.</i>	<i>Communications of the Dublin Institute for Advanced Studies.</i> 64-65 Merrion Square, Dublin.
<i>Instn Elect. Engrs, Monogr.</i>	<i>Institution of Electrical Engineers, Monographs.</i> Savoy Place, W.C.2. [Available separately; to be published in collected form as <i>Proceedings, Part IV.</i>]
<i>J. Japan Soc. Appl. Mech.</i>	<i>Journal of the Japan Society for Applied Mechanics.</i> [Formerly <i>Journal of the Society of Applied Mechanics of Japan.</i>]
<i>Non-Destr. Test.</i>	<i>Non-Destructive Testing.</i> The American Industrial Radium and X-Ray Society, P.O. Box 710, Evanston, Illinois. [Change of address.]
* <i>Suom. Kem.</i>	<i>Suomen Kemistilehti.</i> [<i>Acta Chemica Fennica.</i>] Societas Scientiarum Fennicae, Helsinki.
<i>Tech. Hausmitt. NordwDtsch. Rdfunks</i>	<i>Technische Hausmittelungen des Nordwestdeutschen Rundfunk.</i> Funkhaus Hamburg, Rothenbaumchaussee 132-134, Hamburg 13.
<i>Tekn. Skr, Oslo</i>	<i>Tekniske Skrifter.</i> Norske Ingeniørforening, Kronprinsengate 17, Oslo.
<i>Tekn. Tidskr.</i>	<i>Teknisk Tidskrift.</i> Svenska Teknologföreningen, Box 16368, Stockholm 16. [Change of address.]

NEW JOURNALS

<i>Elliott J.</i>	<i>Elliott Journal.</i> Elliott Bros (London), Century Works, Lewisham, London, S.E.13. Half-yearly: Vol. 1, No. 1, dated March, 1951.
<i>Vacuum</i>	<i>Vacuum.</i> W. Edwards and Co. (London), Worsley Bridge Road, Lower Sydenham, London, S.E.26. Four issues per year; Vol. 1, No. 1, dated Jan., 1951. Annual subscription, British Isles, Northern Ireland and Eire: £1 5s. 0d., all other countries £1 10s. 0d. (U.S. \$4.20), single copies 8s. 6d. (U.S. \$1.20).

MATHEMATICS 51

512.831
4027. The determination of normal coordinates. B. L. CRAWFORD, JR. AND W. H. FLETCHER. Letter in *J. Chem. Phys.*, **19**, 141-2 (Jan., 1951).

512.9
4028. On an application of dimensional analysis. S. F. BORG. *Amer. J. Phys.*, **19**, 69-73 (Feb., 1951).

Based upon dimensional reasoning and utilizing the known invariants of physical tensors, it is shown that the complete forms (except for multiplying constants) of certain differential and integral equations of applied mechanics can be obtained. The procedure equates physical and tensor invariants in a basic postulated form of equation. Just as in ordinary dimensional analysis, the physical terms which enter into any given problem must be known beforehand. In this case, these terms are tensors in addition to the usual physical invariants such as pressure, volume, energy, modulus of elasticity, etc. A.

517.5
4029. Simplified calculation of a linear regression. H. F. SMITH. Letter in *Nature, Lond.*, **167**, 367 (March 3, 1951).

517.76 : 530.145
4030. A canonical transformation in the theory of particles of arbitrary spin. W. A. HEPNER. Letter in *Phys. Rev.*, **81**, 290-1 (Jan. 15, 1951); **82**, 447 (May 1, 1951).

517.942.9
4031. On stability of linear varying-parameter systems. L. A. ZADEH. *J. Appl. Phys.*, **22**, 402-5 (April, 1951).

A linear varying-parameter system is defined to be stable if and only if every bounded input produces a bounded output. It is shown that a necessary and sufficient condition for stability is that the impulsive response of the system $W(t, \tau)$ should be integrable (considered as a function τ) for all t . From this result and the fact that the system function $H(s; t)$ is the Laplace transform of $W(t, \tau)$, it is deduced that a necessary condition for stability of a linear varying-parameter system is that the system function $H(s; t)$ should be analytic and bounded in the right half and on the imaginary axis of the s -plane for all t . This result represents a generalization of the familiar frequency domain criterion which is commonly used in connection with fixed systems. The generalized criterion is applied to the investigation of stability of a variable feedback system. A.

518.4 : 534
4032. On a graphical solution for the forced vibration of a system with non-linear restoring force. Y. SAWARAGI. *Mem. Fac. Engng Kyoto Univ.*, **12**, 95-104 (July, 1950).

The system vibrates under simple harmonic force, and the restoring force may be symmetric or asymmetric. In the former case, the method is explained by solving, in detail, the equation $mx'' + cx' + \alpha x - \beta x^3 = P \sin \omega t$, and the extension of the method is indicated. In the latter case, the equation

solved is $mx'' + cx' + \alpha x + \beta x^2 = P \sin \omega t$. The graphical solution is available for finding resonance curves and phase difference curves in a system with any non-linear restoring force. L. S. GODDARD

518.5
4033. An electronic differential analyzer. A. B. MACNEE. *Research Laboratory of Electronics, Massachusetts Institute of Technology, Tech. Rep. No. 90*, ii + 43 pp. (1948).

A new differential analyser, of 1-10% accuracy, is described. It has low cost, high speed, extreme flexibility and can handle many types of differential equations. It is completely electronic and is suitable for quick exploratory calculations. The output appears as a curve on a c.r.o. Circuits for adding, integrating, multiplying and generating functions are described. The multiplier and function generator use cathode-ray tubes combined with photoelectric cells. Limitations on accuracy are discussed; and a number of special problems are treated.

MATHEMATICAL REVIEWS

518.5
4034. A simplified percent transmission computer. A. L. MCCLELLAN AND G. C. PIMENTEL. Note in *Rev. Sci. Instrum.*, **21**, 1023 (Dec., 1950).

518.5
4035. The solution of differential equations by electrical analog computers. J. L. RYERSON. *Amer. J. Phys.*, **19**, 90-7 (Feb., 1951).

Electrical systems for solving total differential equations are classified as high speed or low speed with citations of existing commercial equipment. A symbolism is proposed for the physical components which perform the mathematical operations without elaborating upon the technical details of their design. The solutions of simultaneous linear algebraic equations, simultaneous differential equations and differential equations with variable coefficients are discussed and illustrated. A.

518.5 : 389.6 : 621.318.572
4036. Standards on electronic computers: definitions of terms, 1950. *Proc. Inst. Radio Engrs*, **39**, 271-7 (March, 1951).

518.5 : 621.318.572
4037. Automatic computing engine of the National Physical Laboratory. M. WOODGER. *Nature, Lond.*, **167**, 270-1 (Feb. 17, 1951).

An outline of the operating principles and facilities of a pilot model. Numerical data and instructions are stored by mercury-tube delay-lines, input and output of such data being by means of punched cards handled at a rate of 100 cards per minute. Calculation proceeds in the binary scale. All computation and manipulation of data are expressed as simple "word" (32 binary digits) transfers between a source and a destination (there are 32 of each). The control of transfer operations by instructions is briefly summarized and some test results are quoted.

A. J. KENNEDY (R)

518.5 : 621.392.6 : 621.318.572

4038. An improved electrical network for determining the eigenvalues and eigenvectors of a real symmetric matrix. A. MANY. *Rev. Sci. Instrum.*, **21**, 972-4 (Dec., 1950).

An electrical computer for determining the eigenvalues and eigenvectors of real symmetric matrices up to the 10th order is described. It is an enlarged and an improved form of a computer previously described [Abstr. 491 (1948)]. The time required for solution is considerably reduced, and the accuracy is ten times higher. The solution of a matrix of the 10th order takes 4 hr, as compared to a 100 hr by computational methods. The accuracy of the eigenvalues is about 0.01% of the difference between the greatest and smallest eigenvalues, and the accuracy

of each eigenvector is better than 1% of its greatest component. A.

519.2 : 621.395.34

4039. On the accuracy of measurements of probabilities of delay and of expected times of delay [in telephone systems]. L. KOSTEN. *PTT-Bedrijf*, **3**, 98-100 (Jan., 1951) In Dutch.

For simple telephone systems with waiting facility, expressions are obtained for the first and second moment of the distributions of the number of delayed calls and of the total time during which all lines are occupied. The non-randomness of delayed calls proves to have a much greater influence than that of lost calls in the corresponding case without waiting facility, which case has been treated previously. A.

ASTRONOMY . ASTROPHYSICS . GEODESY 52

522.6

4040. The artificial repetition of certain short-lived astronomical phenomena by the aid of double-image observations. P. MULLER. *C.R. Acad. Sci., Paris*, **232**, 929-31 (March 5, 1951) In French.

The accuracy with which lunar and planetary occultations may be observed is increased by the use of a double-image micrometer (see *Bull. Astron.*, **14**, 177, 1949). The device is orientated so that double images of star, or satellite (A) appear along the direction of apparent motion towards the lunar, or planetary occulting edge (B). Contacts are observed in the sequence, (i) primary image of (B), and secondary image of (A); (ii) the two primary, or secondary, images (A, B); (iii) primary image of (A), and secondary image of (B). In practice, a series of such sequences is obtained by altering the separation of primary and secondary images. From each artificial occultation the true instant of contact is computed, and the measures combined to yield a result of enhanced accuracy. D. R. BARBER

523.112

4041. Alternative time-dependences of cosmological quantities or scales. M. JOHNSON. Letter in *Observatory*, **71**, 31-2 (Feb., 1951).

Recent theories involve time variation of distance (expanding universe), time-scale (kinematic relativity) or mass (creation theories). It is suggested that these time-dependences may not be independent of one another, the two latter being complementary alternatives. R. A. NEWING

523.112 : 523.852.3

4042. On the distance scale for extra-galactic nebulae. A. BEHR. *Astron. Nachr.*, **279**, 97-104 (Jan., 1951) In German.

A modified estimate of mean absolute magnitude, together with modifications in corrections arising from red-shift, photometric effects and the reddening of distant E nebulae, leads to a new estimate of the recession constant and a doubling of nebular distances. The age of the universe is estimated as $\sim 3.8 \times 10^9$ years. R. A. NEWING

523.161

4043. On the abundance of large interstellar clouds. E. SCHATZMAN. *Ann. Astrophys.*, **13**, 367-83 (Oct.-Dec., 1950) In French.

A study of the reddening of the B-stars, on the basis of the catalogue of Huffer, Stebbins and Whitford (Mt. Wilson Contribution 621, 1940), seems to indicate the presence of large absorbing clouds besides the well-known small ones. Assumptions made are that interstellar clouds are spherical and distributed at random. As to the small clouds, there are about 6 traversed by the light coming from 1000 parsecs distance, and each of them absorbs about 0.28^m . Each of the large clouds, however, according to this new analysis of star counts, seems to absorb about 2.1^m , but their frequency is only 0.6 clouds per 1000 parsecs. An estimate gives 1.4×10^4 solar masses for the total mass of these large clouds within 20 parsecs (there are about 1000 stars in this volume of space). A. BEER

523.161

4044. Interstellar matter. T. D. KINMAN. *J. Brit. Astron. Ass.*, **61**, 70-4 (Feb., 1951).

Discussion of recent work on the nature, structure and distribution of interstellar clouds. A preliminary historical survey concerns the results of Hartmann, Slipher, Beals and Adams, Dunham, Struve and Bok. Then inferences from the distribution of extra-galactic nebulae, from van de Hulst's studies of the composition of the interstellar "grains," from Oort's galactic dynamics as to the density, and from some of Spitzer's new results for the temperature of interstellar matter are dealt with. A. BEER

523.162

4045. The strength of interstellar magnetic fields. L. DAVIS, JR. Letter in *Phys. Rev.*, **81**, 890-1 (March 1, 1951).

The polarization of radiation from distant stars [Hiltner, Abstr. 2309, 5222 (1949)] may imply extensive fields as strong as 10^{-4} gauss. R. A. NEWING

523.165 : 551.594.6 : 621.396.11

Fluctuations in the intensity of radio waves from galactic sources. See Abstr. 4956

523.34 : 551.24

The theory of direct contraction. See Abstr. 4913

523.72

4046. Radio solar-research. M. WALDMEIER. *Naturwissenschaften*, 38 (No. 1) 1-4 (1951) In German.

Survey of lectures on new developments in radio solar research, delivered by various experts in September, 1950, at Zürich in connection with the Congress of the U.R.S.I. (Most of them are still unpublished and will appear later in volume VIII, 1951, of the *Proceedings of the General Assembly of the International Scientific Radio Union*.) Reference is also made to the current publications, *Quarterly Bulletin on Solar Activity* by the Zürich Observatory, and to *Bibliography of extraterrestrial Radio Noise*, issued by the School of Electrical Engineering, Cornell University, Ithaca, New York. Interference observations by Stanier of the centre-limb variations on the sun's disk are compared with the original theory by Waldmeier and H. Müller, and with Waldmeier's new theory. Attention is also drawn to Covington's radio work on the 10 cm solar radiation, and to Piddington's results down to 1 cm. The greater the frequency, the deeper lies the layer from which the radiation originates; variation of the frequency employed thus allows us to explore the various layers, and this helps to construct a new model of the solar atmosphere, which "will certainly supersede, in the near future, the optical models." Furthermore, new work in the meter-wave range is discussed, particularly on isolated and other solar outbursts (Hey, Parsons and Phillips; Stewart; Machin; Laffineur; Wild and McCready; Payne-Scott and Little). The author favours theories connected with pulsations in the solar corona.

A. BEER

523.72

4047. On the interpretation of bursts of solar radio radiation. E.-J. BLUM, J.-F. DENISSE AND J.-L. STEINBERG. *C.R. Acad. Sci., Paris*, 232, 483-5 (Feb. 5, 1951) In French.

The authors have previously shown [Abstr. 3281 (1951)] that solar disturbances at frequencies near 164 Mc/s can be resolved into successive bursts of short duration. It is shown that conditions suitable for the production of such elementary bursts can occur at the front of a shock wave travelling into the corona from the edge of a supersonic jet. The radiation can escape, however, only in the presence of the magnetic field in the neighbourhood of a sunspot.

M. W. OVENDEN

523.72

4048. On a mechanism of coronal radio emission. Y. ROCARD. *C.R. Acad. Sci., Paris*, 232, 598-600 (Feb. 12, 1951) In French.

The polarization produced by a shock wave in the corona, and the stability of the consequent plasma oscillation are examined, and the duration and bandwidth of the bursts of radio emission so produced are found to be in agreement with the observations of Blum, Denisse and Steinberg [Abstr. 3281 (1951)]. The frequency of occurrence of these bursts is also of the right order of magnitude.

M. W. OVENDEN

523.72

4049. The spectral-energy distribution at the centre of the solar disk between 6 700 Å and 23 000 Å. B. PEYTURAUX. *C.R. Acad. Sci., Paris*, 232, 931-2 (March 5, 1951) In French.

Far-red, and infra-red radiation from the central portion of a solar image is suitably reduced in intensity by diaphragms and neutral filters, and compared with that from a W ribbon light-source, using a PbS cell. Intensity measures are corrected for atm. extinction, and found to agree satisfactorily with previous observations of Mulders and Abbot.

D. R. BARBER

523.72 : 537.591.1

4050. On the electromagnetic radiation of cosmic protons in the intense magnetic fields of celestial objects. B. KWAL. *J. Phys. Radium*, 12, 66-7 (Jan., 1951) In French.

The frequency of radiation of cosmic-ray protons of energies 2×10^3 to 2×10^4 MeV in magnetic fields of the order of magnitude of those found in sunspots is calculated to be between 4 and 800 Mc/s for 1 000 gauss and between 16 and 3 200 Mc/s for 4 000 gauss. The intensity of such radiation under solar conditions is found to be $\sim 10^{-10}$ ergs/cm²/sec. The radiation should be emitted preferentially in a plane perpendicular to the magnetic field.

M. W. OVENDEN

523.746

4051. The mean sunspot curve. W. GLEISSBERG. *Istanbul Univ. Obs. Yaz., No. 41* (1951) In German.

This is deduced from all the sunspot cycles observed hitherto, and its properties are investigated. It is shown that the sunspot variations corresponding to this curve are represented by Stewart and Panofsky's formula very approximately. This result leads to some conclusions concerning the rates of the variation of Wolf's relative numbers arising from the formation of new spot groups and from the disintegration of existing groups.

A.

523.746

4052. Statistical research on the floccular cycle. I. Correlation between the activity of sunspots and flocculi. G. RIGHINI AND G. GODOLI. *Mem. Soc. Astron. Ital.*, 22 (No. 1) 3-12 (1951) In Italian.

Correlation coefficients between areas of sunspots and areas of Ca and bright H α -flocculi have been calculated from the monthly means. The floccular activity appears to be delayed by 0.3 month in reference to the activity of the spots.

A.

523.746

4053. Statistical research on the floccular cycle. II. Migration in latitude of flocculi. G. RIGHINI AND G. GODOLI. *Mem. Soc. Astron. Ital.*, 22 (No. 1) 23-32 (1951) In Italian.

Examining 3 solar cycles it has been found that the mean heliographic latitude for sunspots is smaller than that of the bright flocculi. This difference is variable from about 1 to 3 degrees, following the spectral line employed in taking the spectroheliograms. Besides, it appears that this difference is correlated with the observed chromospheric level.

A.

523.841.1

4054. Remarks on the nova phenomenon. III. E. SCHATZMAN. *Ann. Astrophys.*, **13**, 384-9 (Oct.-Dec., 1950) *In French*.

For Part II see Abstr. 3722 (1950). The shock wave produced by a plutonium bomb in a mixture of D_2O and T_2O could develop into a detonation wave involving the reaction $T + D \rightarrow \alpha + n + 17.6$ MeV. This process is suggested as a qualitative representation of a nova eruption, but a quantitative description of processes occurring under stellar conditions requires further investigation.

R. A. NEWING

523.851

4055. On the formation of double stars. L. E. GUREVICH AND B. J. LEVIN. *Astron. J., USSR*, **27** (No. 5) 273 (1950) *In Russian*. English abstract in *Astron. News Lett. [Harvard] No. 54*, 8 pp. (1951).

An equilibrium theory of binaries, along the lines proposed by Ambarzumian, is discussed. Near the sun, present conditions are unsuited to the formation of the obsd. distribution of binary stars. It is suggested that the nearer double-stars were formed in clusters; and later became detached. The proposed theory contradicts that of Jeans.

D. R. BARBER

523.851.1

4056. A theoretical investigation of evolution of stellar clusters. M. WÄHNL. *S.B. Öst. Akad. Wiss., Abt. IIa*, **158** (No. 6-10) 227-59 (1950) *In German*.

The major axis and eccentricity of a binary system are found to increase under the gravitational action of a spherical cluster through which the binary is assumed to move. By analogy, the galactic field is expected to cause the decay of globular clusters into open clusters, and finally into isolated stars.

R. A. NEWING

523.852.22

4057. On the radiation pressure in a planetary nebula. I. W. UNNO. *Proc. Japan Acad.*, **26** (No. 6) 17-22 (1950).

The equation of transfer for Lyman α -line radiation is solved by an approx. method in which the line contour is divided into ranges for which the nebula is respectively opaque and semi-transparent. In central regions of the nebula, radiation pressure is found to be much smaller than in previous estimates.

R. A. NEWING

523.855

4058. Remarks on the mean absolute magnitude and the radial-velocity/apparent-magnitude relation for extra-galactic nebulae. J. BIGAY. *C.R. Acad. Sci., Paris*, **232**, 690-2 (Feb. 19, 1951) *In French*.

Using Fabry apparent magnitudes, the mean abs. mag. of 64 nebulae is found to be -14.9 in place of the Hubble value -14.2 . Data for 47 brighter nebulae satisfy the linear velocity-distance law if Fabry magnitudes are employed.

R. A. NEWING

523.872

4059. The atmospheres of the early type stars. C. S. BEALS. *J. Roy. Astron. Soc. Can.*, **44**, 221-40 (Nov.-Dec., 1950).

The general review covers the influence of the

Stark effect and of atmospheric motions on line profiles, and also discusses temperature scales derived from absorption and emission lines. The place of W stars and the hotter planetaries in the stellar sequence is considered.

R. A. NEWING

523.872 : 523.72

4060. Brightness temperature and opacity of stellar atmospheres: application to the Sun. D. CHALONGE, L. DIVAN AND V. KOURGANOFF. *Ann. Astrophys.*, **13**, 347-54 (Oct.-Dec., 1950) *In French*.

From the Eddington-Barbier relation it is shown that the brightness temp. (T_b) of radiation at wavelength, λ , in a direction, θ , to the emitting surface, is equal to that temp. (T) which exists at an optical depth, $\tau_\lambda = \cos \theta$, in the stellar atmosphere; and that its variation with λ gives qualitative information on the connection between atm. opacity and wavelength. The treatment is applied to an interpretation of the continuous radiation from the centre of the solar disk.

D. R. BARBER

523.875

4061. A determination of the effective temperature of a white-dwarf showing faint H emission (lines). P. COUTEAU. *C.R. Acad. Sci., Paris*, **232**, 797-8 (Feb. 26, 1951) *In French*.

Considering only radiation from the centre of the stellar disk, an expression is obtained for the coeff. of absorption at distance, $\Delta\lambda$, from the centre of an emission-line, wavelength, λ , and applied to an estimation of the effective temp. of the white-dwarf, AC + 70° 8 247. Using data from a McDonald spectrogram, and assuming a surface-gravity factor, $10^{8.5}$, the obsd. 1% emission at 50 Å from centre of H_γ , and $\frac{1}{2}\%$ absorption at the centre of the same line, correspond to an effective temp. of 620 000°K. If the radiation is integrated over the whole disk emission will be enhanced, and the obsd. intensities will correspond to a lower effective temperature.

D. R. BARBER

523.877

4062. On the anisotropy of radiation in stellar atmospheres, and the errors that result in "the Eddington approximations." V. KOURGANOFF. *Astrophys. Norveg.*, **5**, (No. 1), 18pp. (Jan., 1949) *In French*.

The approximations considered are (i) $I(\tau) = 3K(\tau)$, where I is the mean intensity of radiation and K the "radiation pressure" integral, $(I - 3K)/I$ being regarded as an "index of anisotropy"; and (ii) $I(0) = \frac{1}{2}F$ at the surface. Estimated errors, based on exact solutions [Abstr. 3666-8 (1947)] in the case of a grey atmosphere, and in the general case upon an empirical darkening law, are found to be $\sim 30\%$ near the surface. Errors in (i) and (ii) have opposite effects so that the formula $T^4 = T_e^4(2 + 3\tau)$ is reasonably accurate for $\tau \geq 0.2$.

R. A. NEWING

523.877

4063. Concerning the Wolf-Rayet stars. P. BOUVIER. *Arch. Sci.*, **3** (No. 6) 458-60 (1950) *In French*.

It is shown that Compton scattering is able to explain the migration of free electrons to the exterior of the gaseous envelope surrounding a Wolf-Rayet star.

M. W. OVENDEN

- 523.877
4064. The atmospheres of the early-type stars. C. S. BEALS. *Trans. Roy. Soc. Can.*, **44**, 1–23 (June, 1950).
 A general survey of the problems of interpreting early-type spectra. M. W. OVENDEN

- 523.877
4065. The structure of stellar atmospheres. IV. E. VITENSE. *Z. Astrophys.*, **28** (No. 2) 81–112 (1951) *In German*.

For Parts I–III see Abstr. 5909–11 (1949). The continuous absorption coeff. and the Thomson and Rayleigh scattering coeff. are calculated as functions of wavelength for an Unsöld atmosphere for various temperatures and electron pressures in the range $3\ 840^\circ \leq T \leq 100\ 800^\circ$ and $0.5 \leq \log P_e \leq 5$. The Rosseland mean is also given as a function of gas pressure and temperature. R. A. NEWING

- 523.877
4066. On the polarization of radiation in stellar atmospheres. H.-H. VOIGT. *Z. Astrophys.*, **28** (No. 2) 176–202 (1951) *In German*.

A method analogous to Zanstra's [*Mon. Not. Roy. Astron. Soc.*, **101**, 250–65 (1941)] is used in which a first approx. is obtained from Schuster's formulae, the incident radiation being unpolarized; a second approx. is obtained by iteration. The method is applied to continuous and to line spectra. R. A. NEWING

- 523.877 : 523.7 : 523.4
4067. Studies in hydrodynamics and structure of stars and planets. J. WASIUTYŃSKI. *Astrophys. Norveg.*, **4**, 497 pp. (1946).

The central thesis of the work is that the problem of the structure of celestial bodies cannot be separated from considerations of their internal motions, and many properties of the Sun, stars and planets are explained in terms of turbulence, convection and Bénard circulation. A highly critical account of previous work is given, together with original contributions in the form of modifications and extensions of existing theories. An extensive bibliography covers publications up to 1942. The mechanical and thermal effects of turbulence in rotating stars are first considered; a new physical interpretation of the Prandtl theory is given, and the theory is developed for three dimensional motions. Large-scale currents are also considered and stability criteria are discussed in detail. In an extensive discussion of the hydrodynamics of solar activity, sunspots are explained in terms of violent turbulence arising from inertial instability; problems concerning solar rotation and equatorial acceleration are also examined. Solar granulation is

considered to arise from thermally maintained gravitational instability, the granules being explained in terms of Bénard convection cells; the surface features of the Earth, Moon and Mars are attributed to the same cause. It is suggested that much information concerning the motion of the outer layers of the Sun might be obtained from a study of abnormal granular forms arising from variations in local conditions. Belt currents in rotating planetary atmospheres are discussed. Detailed consideration is given to convection currents in rotating spherical layers of gas heated from within and attracted to the centre, approximate solutions being given for rotationally symmetrical flows and computed numerically for rapidly rotating thin layers. Slowly rotating shells of finite thickness are also investigated, and the theory is applied to general circulation in the atmospheres of the major planets. Stars with convective cores are classified according to heat transport, radiative (R) or convective (C), in the outer and intermediate layers, and the four possible models are discussed. An RR model with $p_R/p_G = 0.25$ is computed numerically, and formulae for the luminosity and radius of CC stars are established. Giant stars are included in the RC class. Stellar evolution is then considered, and the non-homologous transformations of RR and CC stars are discussed. R. A. NEWING

- 525.38
4068. Variations in the length of the day. R. I. B. COOPER. *Nature, Lond.*, **167**, 297–8 (Feb. 24, 1951).

Three types of variation are known: slow secular lengthening, periodic variation (period, 1 yr), and superposed irreg. fluctuation. The first is accounted for by energy dissipation in narrow seas, e.g. Behring Straits; the second, discovered by analysis of quartz-clock errors, is in the sense that the earth is slow in spring and fast in autumn, the variation amounting to ± 1 millisec/yr. By including known effects of latitude on barometric pressure, and changes in angular momentum of atmosphere, a periodic term c. 1/10 amplitude of that observed is obtained. An explanation of the residual effect is not yet evident. In the absence of a detailed analysis of the third type, it is not possible to account for the irregular fluctuations, although it is unlikely that these arise solely from large-scale movements of material over the earth's surface. D. R. BARBER

- 529.7 : 621.317.36
4069. The determination of time and frequency. H. M. SMITH. *Proc. Instn. Elect. Engrs, Pt II*, **98**, 142–53 (April, 1951) [Reprint No. 1054].

For abstract see Abstr. 61 (1951).

PHYSICS 53

- 53.081.1
4070. The permicron: a unit of wave number. N. S. BAYLISS. Letter in *Nature, Lond.*, **167**, 367–8 (March 3, 1951).

The number of waves per micron is more convenient than the number of waves per cm for measurements of low accuracy. 1 permicron = 10^4 cm⁻¹.

A. G. GAYDON

FUNDAMENTALS 530.1

- 530.1
4071. On the persistence of geometrical structures in the development of physical theories. F. AESCHLIMANN. *C.R. Acad. Sci., Paris*, **232**, 695–7 (Feb. 19, 1951) *In French*.

Logical discussion of the relationship that must exist

between one theory and another with a wider domain of validity. The conditions for the existence of a "correspondence principle" are obtained. J. R. MADDOX

530.12

4072. Unified field theory. M. WYMAN. *Canad. J. Math.*, 2 (No. 4) 427-39 (1950).

In the Einstein-Straus unified field theory [*Ann. Math.*, 47, 731-41 (1946)] a rigorous solution obtained by Papapetrou [Abstr. 4453 (1949)] is examined and generalized. A connection between this theory and general relativity, alternative to that of Papapetrou, is discussed, and it is shown that the boundary conditions are not yet unique. All solutions yet obtained reduce to the Schwarzschild solution under the stronger of these boundary conditions, suggesting that description of combined gravitational and electromagnetic fields requires still more general solutions.

R. H. DALITZ

530.12

4073. Discrete space-time and integral Lorentz transformations. A. SCHILD. *Canad. J. Math.*, 1 (No. 1) 29-47 (1949).

A model of discrete space-time consisting of a four-dimensional hypercubic lattice is investigated. It is shown to be invariant under a restricted class of Lorentz transformations.

P. T. LANDSBERG

530.12

4074. On the motion of particles in general relativity theory. A. EINSTEIN AND L. INFELD. *Canad. J. Math.*, 1 (No. 3) 209-41 (1949).

An earlier derivation of the equations of motion from the field equations [*Ann. Math.*, 41, 455 (1940)] is re-examined to meet the criticism that the approximation procedure employed did not ensure that the field equations were soluble to an arbitrary high approximation. A new system of successive approximation is developed in which field quantities are expanded in terms of an arbitrary parameter λ , and it is shown that integrability at any stage of the approximation can be ensured by introducing certain dipole terms. These terms are removed after the total field has been calculated to the required degree of approximation, and the removal process gives 3p differential equations defining the motion of the p particles to the degree of approx. considered.

R. A. NEWING

530.12

4075. The Bianchi identities in the generalized theory of gravitation. A. EINSTEIN. *Canad. J. Math.*, 2 (No. 1) 120-8 (1950).

When extending the theory of gravitation to non-symmetric g_{ik} fields, there are many possibilities from which a choice must be made. The object of the present paper is to show that the choice leading to the field equations already established [Abstr. 4684 (1950)] is the "natural" generalization of the symmetric field theory. Conjugate tensors are defined, and the requirement is made that conjugates should play equivalent roles in the field equations; this determines the order of the indices in the equation $g_{ikl} - g_{sk} \Gamma_{il}^s - g_{is} \Gamma_{lk}^s = 0$, which is taken over from symmetric theory. Compatibility conditions for the field equations are set up by contracting the analogues of the Bianchi identities, symmetry and

antisymmetry becoming replaced by Hermitian and anti-Hermitian properties. The new derivation of the field equations is compared with the previous derivation from a variational principle in which *a priori* restrictions on the g - Γ field were introduced.

R. A. NEWING

530.12

4076. On the extended theory of gravitation. I. O. HECKMANN, P. JORDAN AND W. FRICKE. *Z. Astrophys.*, 28 (No. 2) 113-49 (1951) *In German*.

There are two possible sets of field equations for projective relativity in which the "constant" of gravitation κ is treated as a field variable, (i) Jordan's equations derived by contraction of the five-dimensional curvature tensor [Abstr. 2017 (1947)], and (ii) the equations used by Ludwig [Abstr. 3739 (1950)] involving a dimensionless parameter ζ . Two-parameter, static, spherically symmetric families of solutions for free space in the absence of electromagnetic fields are derived in the two cases, the Schwarzschild solution of general relativity being included as the special case $\kappa = \text{const}$. The solutions are applied to planetary motion, and it is concluded that the gravitational field of the sun must approximate very closely to the Schwarzschild solution, thus permitting only slight variation of κ with radial distance. The solutions give the usual gravitational red-shift, and, for approximately Schwarzschild fields, Einstein's estimate of the deflection of light in the neighbourhood of the sun. The parameters involved in either of the two sets of solutions can be evaluated for the gravitational field outside a spherically symmetric mass of small density. Equations (ii) then give an approximately Schwarzschild field for sufficiently large values of ζ , but equations (i) give a strong divergence from such a field.

R. A. NEWING

530.145

4077. The advent of the quantum theory. A. EINSTEIN. *Science*, 113, 82-4 (Jan. 26, 1951).

530.145

4078. Fifty years of quantum theory. A. SOMMERFELD AND F. BOPP. *Science*, 113, 85-92 (Jan. 26, 1951).

530.145

4079. Quantum theory and chemistry. L. PAULING. *Science*, 113, 92-4 (Jan. 26, 1951).

530.145

4080. Conceptual foundations of the quantum theory. H. MARGENAU. *Science*, 113, 95-101 (Jan. 26, 1951).

530.145

4081. Fifty years of quantum theory. W. HEISENBERG. *Naturwissenschaften*, 38 (No. 3) 49-55 (1951) *In German*.

A commemoration address, beginning from the first origins of quantum theory, the experimental data of 1900 which led Planck to the concept of "quantum of action," and telling an inside story of the considerations leading to the mathematical formulation of quantum theory and its integration into physical philosophy. The spread of its applications to diverse fields is broadly sketched, together with an outline of the more recent fundamental developments.

R. H. DALITZ

4082. **Two-electron angular wave functions.** E. HYLLERAAS. *Avh. Norske Vidensk. Akad. Oslo, I. Mat.-Nat. Kl., No. 1-5, 18 pp.* (1949).

The possibility of separating 3 angular variables for all states of the 2-electron problem was proved by Breit in 1930. Difficulties, however, remained when dealing with exchange. It is proved that the appropriate procedure for removing these difficulties is to quantize separately the angular momenta of the 2 electrons. This is particularly useful for the treatment of doubly excited states and of collision problems. Angular wave functions are constructed, corresponding to given values of the total and individual angular momenta.

L. PINCHERLE

4083. **Generalised Hamiltonian dynamics.** P. A. M. DIRAC. *Canad. J. Math.*, **2** (No. 2) 129-48 (1950).

A Hamiltonian theory applicable when the momenta are not independent is formulated; the general case is shown derivable from a Lagrangean linear in the velocities. The interdependence of the momenta leads to weak (i.e. valid only for the actual motion) consistency conditions ($\phi_n = 0$), which are proved consistent with the equations of motion (of the usual Hamiltonian form, in terms of a suitable Poisson bracket (P.b.) notation). ϕ_n is "first" or "second" class according as the P.b.'s with all ϕ_m vanish or not, weakly; to each 1st class ϕ corresponds an arbitrary function in the solution for the system, 2nd class ϕ conditions become strong (i.e. identities) by redefinition of P.b. A relativistic theory may specify the system on a series of space-like surfaces, in which case infinitely many ϕ are first class. In the quantized theory, strong equations become operator equations, whilst weak equations become conditions on the state vector.

R. H. DALITZ

4084. **Diverging integrals in the self-charge problem.** J. MCCONNELL. Letter in *Phys. Rev.*, **81**, 275 (Jan. 15, 1951).

By a suitable definition of the divergent integrals in 2nd-order vacuum polarization due to vector mesons, the divergence is reduced sufficiently to be cancelled by the vacuum polarization divergence due to electron pairs. However, other divergent terms occurring in the former cannot be cancelled by such a mixture of fields.

R. H. DALITZ

4085. **On the definition and approximation of Feynman's path integrals.** C. MORETTE. *Phys. Rev.*, **81**, 848-52 (March 1, 1951).

A general and compact expression for Feynman's path integral has been obtained. A classical method is given for the computation of such expressions. The example of a Dirac particle in a constant external electromagnetic field is treated by this method.

A.

4086. **Formulation of a divergence-free quantum-electrodynamics.** G. LUDWIG. *Z. Naturforsch.*, **5a**, 637-42 (Dec., 1950) *In German*.

It is shown that it is possible to write Feynman's description of the electromagnetic field so that, by

taking account of a suitable definition of the vacuum, an electron has no self-energy.

J. R. MADDOX

4087. **The energy-momentum vector in the unitary divergence-free quantum electrodynamics.** H. KÜM-MEL. *Z. Naturforsch.*, **5a**, 642-4 (Dec., 1950) *In German*.

The classical potential $A_\mu = \frac{1}{2}(A_\mu^{\text{adv}} + A_\mu^{\text{ret}})$ is shown to lead to an energy-momentum vector which, with Ludwig (see previous Abstr.) has no self-energy for an electron.

J. R. MADDOX

4088. **The Hamiltonian form of field dynamics.** P. A. M. DIRAC. *Canad. J. Math.*, **3** (No. 1) 1-23 (1951).

For relativistic dynamics in which the system is described on "instants" (space-like surfaces τ), the surface variables should be treated as dynamical variables, so that solutions corresponding to a given action may be discussed as a family, in the spirit of Schrödinger wave mechanics. However, dependence of the surface variables on τ contains a certain degree of arbitrariness, for which situation a generalized Hamiltonian theory developed by the author [Abstr. 4683 (1951)] may be applied directly. The formalism is exemplified by the scalar-meson and vector-meson fields, leading then to the electromagnetic field which is here treated without the supplementary condition. A wider class of gauge transformations is then available, but gauge invariant quantities agree with the conventional theory. Quantization is direct, but the resultant treatment of longitudinal field variables differs from usual quantum electrodynamics.

R. H. DALITZ

4089. **The Wheeler-Feynman theory of electromagnetic interaction.** O. COSTA DE BEAUREGARD. *Rev. Sci., Paris*, **88**, 34-40 (Jan.-March, 1950) *In French*.

The Wheeler-Feynman classical radiation theory is concisely expounded, and compared with other radiation theories. A physical illustration of the theory is discussed in the appendix to point out that paradoxical effects should be expected in sufficiently fine experiments though largely the effects of the advanced waves will be practically undetectable in statistical macroscopic experiments.

R. H. DALITZ

4090. **Numerical evaluation of the Fermi beta-distribution function.** D. G. E. MARTIN. Letter in *Phys. Rev.*, **81**, 280-1 (Jan. 15, 1951).

It is expedient to expand $\ln(x + iy)$ as a Taylor series and to use tabulated values of the polygamma functions that occur. In calculating $|\ln\Gamma(n + iy)|$ use is made of the relation $\ln\Gamma(z) = \ln\Gamma(z + k) - \ln(k)$ to secure more rapid convergence of the series.

J. R. MADDOX

4091. **On the diagonalization of the Hamiltonian in the theory of wavefields, and on the theory of closed systems.** I. B. FERRETTI. *Nuovo Cim.*, **8**, 108-31 (Feb., 1951) *In Italian*.

It is suggested that a treatment which should lead to the elimination of the divergences in the theory of

wavefields would be also a theory of elementary particles, considered as closed systems, and of the proper values of the energy of such systems. Therefore it appears desirable to extend Dyson's analysis to the case of closed systems. In this preliminary paper several formal questions are discussed concerning such extension, particularly in order to show that Dyson's method can essentially be used in the calculation of the proper values of the energy when the perturbation theory is applicable.

L. PINCHERLE

530.145

4092. On the theory of the generalized double Compton scattering. G. PETIAU. *C.R. Acad. Sci., Paris*, **232**, 701-3 (Feb. 19, 1951) *In French*.

The general cross-section is obtained for the process where a Dirac particle absorbs a particle of spin 0 or 1 and emits two particles of spin 0 or 1, all three being distinct particle fields. The evaluation is carried through when all three are pseudoscalar. G. J. KYNCH

530.145

4093. Internal excitation and apparent range of nuclear forces in scattering experiments. G. BREIT AND M. C. YOVITS. *Phys. Rev.*, **81**, 416-24 (Feb. 1, 1951).

The effect of a speculatively considered internal excitation of nucleons on the scattering of elementary particles is examined by means of a schematic model. It is found that the relation between the integral of the square of the wave function describing the normal nucleonic state and the apparent range of force differs from that expected on the ordinary potential energy description. The effect is of the order of 8% if one assumes the excitation to be $275 mc^2$. The direction of the effect is such as to decrease the apparent range as though the meson mass were increased, somewhat as indicated by a comparison of the mass of a π -meson with experiments on scattering. A possible necessity of corrections for the velocity dependence of nuclear forces which is considered above is briefly discussed in connection with the correlation of data on scattering with that on binding energies. A.

530.145

4094. Consequences of gauge invariance for radiative transitions. R. G. SACHS AND N. AUSTERN. *Phys. Rev.*, **81**, 705-9 (March 1, 1951).

Consideration is given to any system of particles whose behaviour under the influence of an external electromagnetic field can be described by a gauge invariant Schrödinger equation. Detailed restrictions on the form of the Hamiltonian which are imposed by the condition of gauge invariance are derived. These provide a simple means to the solution of many problems of the interaction of a system with the electromagnetic field. In particular, the following consequences are established: (1) In multipole expansions for single photon processes the electric multipole operators have the usual form but the form of the magnetic multipole operators may depend in a detailed way on the interactions between particles and electromagnetic field. (2) The f -sum rule can be expressed in closed form in terms of the interactions. (3) A generalization of the f -sum rule to all electric multipole orders is given. (4) The cross-section for scattering of a low-energy photon can be expressed in terms of

the electrostatic polarizability quite independently of the interactions. Applications of these methods to problems in nuclear physics are given in an accompanying paper (Abstr. following). A.

530.145

4095. Interaction effects on radiative transitions in nuclei. N. AUSTERN AND R. G. SACHS. *Phys. Rev.*, **81**, 710-16 (March 1, 1951).

Electromagnetic transition processes in nuclei are considered on the assumption that the influence of an external electromagnetic field on a nucleus can be incorporated into a gauge invariant Schrödinger equation for the nucleons (phenomenological theory). From the results reported in preceding Abstr. it is concluded that equations for electric multipole transition probabilities have the usual form but that the f -sum rule is modified in a manner depending on the nuclear interactions. Explicit expressions for the generalization of the f -sum rule to all electric multipole orders are given for exchange and velocity-dependent interactions. The magnetic multipole moments, and therefore the corresponding transition probabilities, depend markedly on the form of the interaction with the electromagnetic field. General formulae are given for all magnetic multipole moments of nuclei in which exchange forces and velocity-dependent interactions play a role. In addition it is possible to incorporate into the theory the spin-antisymmetric addition to the magnetic dipole moment implied by the static moments of H^3 and He^3 . Detailed application is limited to magnetic dipole transitions. The theoretical cross-section for the capture of thermal neutrons by protons is found to have about a 4% addition, due entirely to the spin-antisymmetric term. In heavier nuclei this spin term, exchange interactions, and the velocity interaction proposed to account for high energy nucleon-nucleon scattering contribute to the magnetic dipole transitions. The ratio of magnetic dipole to electric quadrupole transition probabilities is of the order of $(25/\hbar\omega)^2 A^{-4/3}$, where A is the nuclear mass number and $\hbar\omega$ is the photon energy in MeV. Similar emphasis of the magnetic over electric transitions at low energies is anticipated for higher multipole orders, so interpretations of isomeric transitions on the basis of lifetime require re-examination. A.

530.145

4096. Radiative processes in the presence of heavy nuclei. G. PARZEN. *Phys. Rev.*, **81**, 808-14 (March 1, 1951).

Calculations of the cross-sections for bremsstrahlung and pair production are carried out without the use of the Born approximation, but by reducing the calculation of these cross-sections to the calculation of the exact elastic scattering of electrons and positrons, the last quantities having been tabulated to some extent. Large deviations from the Born approximation results are obtained in the angular distributions of these radiative processes, but arguments are presented that the Born approximation should yield the integrated cross-sections correctly at sufficiently high energies. The failure of the Born approximations for relativistic equations is explained in a purely classical way. A.

530.145
4097. Retarded nuclear interaction. S. T. MA. Letter in *Phys. Rev.*, **82**, 275 (April 15, 1951).

The inter-nucleon interaction due to exchange of a single meson is examined, according to Tomonaga-Schwinger formalism. In perturbation theory, this interaction gives results different from that of van Hove [see Abstr. 4459 (1949)] if intermediate states of negative energy are concerned, and, if not, both interactions give log-divergent, 2nd-order perturbation expressions, though the interaction due to exchange of two mesons is finite.
R. H. DALITZ

530.145
4098. Charge renormalization in the Hartree approximation. H. S. SNYDER. Letter in *Phys. Rev.*, **82**, 279 (April 15, 1951).

Charge renormalization and the relation of the renormalized current to the fictitious external current are discussed in the approximation where the electron-positron current operator is replaced by its expectation value.
R. H. DALITZ

530.145 : 539.151
4099. On the Lamb shift for spinless electrons. W. A. NEWCOMBE AND F. ROHRlich. Letter in *Phys. Rev.*, **81**, 282-3 (Jan. 15, 1951).

The value obtained using Feynman's method is 956 Mc/s for H. The difference between this and that of Dyson's non-covariant method [Abstr. 1890 (1948)] is discussed, and the origin of its errors. The result of Sasaki and Suzuki [Abstr. 5505 (1950)] is essentially the same, but there is a slight difference in their numerical factor, due possibly to a numerical error.
G. J. KYNCH

530.145
4100. On the relativity and spin corrections for a particle in a central field. A. BERNASCONI AND P. CALDIROLA. *Nuovo Cim.*, **8**, 71-3 (Jan., 1951) *In Italian*.

Sewell's approximate method of integration of the Dirac and Klein-Gordon equations [see Abstr. 709 (1950)] is extended to the case in which the force acting on the particle derives from a scalar potential. This study confirms that these corrections depend very markedly on the nature of the field.
L. PINCHERLE

530.145
4101. Neutron-deuteron scattering at very low energies. A. TROESCH AND M. VERDE. *Helv. Phys. Acta*, **24** (No. 1) 39-48 (1951) *In German*.

An expansion of the phase for *S*-wave scattering in powers of the energy has been obtained, exactly as for two-body scattering. The lowest-order and the next higher-order terms are calculated by the method previously described [Abstr. 8238 (1950)] using Gaussian potentials and wave-functions for the deuteron. The scattering lengths $a_{\frac{3}{2}}$ and $a_{\frac{1}{2}}$ for the two spin states $\frac{3}{2}$ and $\frac{1}{2}$ are 2.8 and 6.8 in neutral theory, 3.2 and 7.0 in symmetrical theory, in units 10^{-13} cm.
G. J. KYNCH

530.145
4102. Scattering and absorption of scalar and pseudoscalar mesons by nucleons. M. PESHKIN. *Phys. Rev.*, **81**, 425-9 (Feb. 1, 1951).

Cross-sections have been calculated for scattering

of pi-mesons by nucleons and for absorption of the charge of the meson in the scattering process. Computations are carried out to 2nd order in g^2 , using scalar and pseudoscalar fields with scalar and pseudoscalar coupling, respectively. It is found that there are strong qualitative differences in the cross-sections depending upon field type and upon the type of mixture where neutral mesons are concerned.
A.

530.145
4103. On the evaluation of the *S*-matrix. F. COESTER. Letter in *Phys. Rev.*, **81**, 455-6 (Feb. 1, 1951).

The number of equivalent terms in the n th order term of the *S*-matrix are given by general formulae obtained by the method of Wick [Abstr. 853 (1951)].
G. J. KYNCH

530.145
4104. Overlapping divergences and the *S*-matrix. A. SALAM. *Phys. Rev.*, **82**, 217-27 (April 15, 1951).

By extending considerations given by Dyson, general rules are obtained for isolating divergent parts from integrals corresponding to overlapping graphs, and a proof is obtained for the appearance of an extra factor Z_1^{-1} from "b divergences." In the last section the possibility of renormalization for scalar meson-nucleon interactions is demonstrated.
A.

530.145
4105. Transmutation of the fundamental particles. Change of spin. A. PROCA. *J. Phys. Radium*, **12**, 123-30 (Feb., 1951) *In French*.

General equations are set up to describe all particles as distinct states of a single particle. Only dependence on spin is considered here. The wave-equations are $\{\Sigma(p_k + u_k)^2 + \mu^2 c^2\} \psi(x_k, \xi_k) = 0$, where u_k are functions of the spin variables ξ_k and the corresponding momenta, defined by the relations $\mu v_k = p_k + u_k$, where v_k is the particle velocity. The form of u_k is chosen on grounds of simplicity. Equations are obtained for integral spin where either the mass is independent of spin, or else it depends on spin in an unusual way. A particle of given spin is described by the equations of Fierz, but it can also be found in other states of different spin. The relation of particles of integral spin to those of spin $\frac{1}{2}$ is described in an appendix.
G. J. KYNCH

530.145.6
4106. The quantification of space and time in wave mechanics. D. M. CASESNOVES. *Euclides*, **10**, 247-50 (July-Aug., 1950) *In Spanish*.

530.145.6
4107. The quantification of mass and velocity and the uncertainty of absolute repose, in wave mechanics. D. M. CASESNOVES. *Euclides*, **10**, 336-9 (Oct., 1950) *In Spanish*.

530.145.6
4108. The cosmological and cosmogonical consequences of my theory of the discontinuity of the wave-mechanics variables.—Calculation of the photon mass upper limit. D. M. CASESNOVES. *Euclides*, **10**, 385-9 (Nov., 1950) *In Spanish*.

530.145.6

4109. Original calculation of the number of electrons and protons in the universe—Demonstration that the position of the photon cannot be observed in wave mechanics. D. M. CASESNOVES. *Euclides*, **10**, 427–32 (Dec., 1950) *In Spanish*.

530.145.6

4110. On the possibility of spin models. F. BOPP AND R. HAAG. *Z. Naturforsch.*, **5a**, 644–53 (Dec., 1950) *In German*.

Half-integral spherical harmonics are shown to have transformation properties that allow them to represent states of total angular momentum in Hilbert space. Separation of the Schrödinger equation for the two-electron problem, however, leads to non-regular solutions. This reflects the fact that only $M = M_1 + M_2$ has direct physical significance.

J. R. MADDUX

530.145.6

4111. Material waves. M. v. LAUE. *Naturwissenschaften*, **38** (No. 3) 55–61 (1951) *In German*.

Discusses the wave-like behaviour of electrons, neutrons, etc., as evidenced by crystalline diffraction and, in the case of electrons, the production of Fresnel fringes. This behaviour is explained in terms of the quantum theory in general and the de Broglie theory in particular, and a concluding section is devoted to a consideration of the implications of the dual nature of material particles.

J. THEWLIS

530.145.6

4112. Singular solutions of Dirac equations, taking account of an external magnetic field. J. GEHENIAU AND M. DEMEUR. *Physica*, **17**, 71–5 (Jan., 1951) *In French*.

In this work, the singular matrices of the Dirac equations, for an electron placed in a uniform and constant magnetic field are calculated without approximation in respect to this field. Integral representations of S and S_F are given.

A.

530.145.6

4113. A simplification of the Hartree-Fock method. J. C. SLATER. *Phys. Rev.*, **81**, 385–90 (Feb. 1, 1951).

It is shown that the Hartree-Fock equations can be regarded as ordinary Schrödinger equations for the motion of electrons, each electron moving in a slightly different potential field, which is computed by electrostatics from all the charges of the system, positive and negative, corrected by the removal of an exchange charge, equal in magnitude to one electron, surrounding the electron whose motion is being investigated. By forming a weighted mean of the exchange charges, weighted and averaged over the various electronic wave functions at a given point of space, an average potential field is set up in which all of the electrons can be considered to move, thus leading to a great simplification of the Hartree-Fock method, and bringing it into agreement with the usual band picture of solids, in which all electrons are assumed to move in the same field. The average exchange charge can be replaced by the corresponding value which would occur in a free-electron gas whose local density is equal to the density of actual charge at the position in question; this results in a very simple expression for the average potential field, which still behaves

qualitatively like that of the Hartree-Fock method. This simplified field is being applied to problems in atomic structure, with satisfactory results, and is adapted as well to problems of molecules and solids. A.

530.145.6

4114. On the theory of angular correlation phenomena. L. EISENBUD. *J. Franklin Inst.*, **251**, 231–46 (Feb., 1951).

The correlation distribution function for emissions of non-relativistic particles in two successive disintegrations of a system is calculated without the use of perturbation theory and without particular assumptions for the nature of the "interactions" responsible for the transitions. The calculation is limited to transitions with the emission of only one particle (or more precisely, the disintegration of a quasi-stationary system into two sub-systems). Some general properties of correlation distribution functions are obtained. Also the number of undetermined parameters which enter the distribution function is counted under important restricting conditions. The form of the calculation makes possible the exhibition of the formal identity of the correlation distribution function with the angular distribution function for resonance reactions. Both distribution functions may be represented as polynomials in $\cos^2 \theta$ of degree not greater than J , where J is the spin of the intermediate states of the two processes.

A.

530.145.6

4115. On systems which admit a quadratic first integral other than the energy. M. CAZIN. *C.R. Acad. Sci., Paris*, **232**, 688–90 (Feb. 19, 1951) *In French*.

The conditions for the existence of the integral are stated and the two-dimensional problem is examined. The external potential then satisfies two conditions. Various types of potential of a suitable type are written down.

G. J. KYNCH

530.145.6

4116. Variation of the distribution function of the four-operator $(-\hbar/2\pi i)\partial_k$ in a transition. Equivalence between our theory and Feynman's theory of the positron. O. COSTA DE BEAUREGARD. *C.R. Acad. Sci., Paris*, **232**, 927–9 (March 5, 1951) *In French*.

The formula obtained by this theory for the variation in space-time of the energy-momentum density is the same as the series expansion of Feynman using a Green's function. The essential ideas of the theory are restated.

G. J. KYNCH

530.145.6

4117. Diverging potentials and the virial theorem. A. ORE. *Letter in Nature, Lond.*, **167**, 402–3 (March 10, 1951).

The virial theorem in its quantum mechanical form is used to show that for particles interacting according to a $-Cr^{-n}e^{-\lambda r}$ law, a necessary condition for stability is $n < 2$.

W. J. SWIATECKI

530.145.6

4118. Reflections in one-dimensional wave mechanics. R. LANDAUER. *Phys. Rev.*, **82**, 80–3 (April 1, 1951).

A method is presented for solving the one-dimensional Schrödinger equation. The method gives the wave function in the form of an infinite series. The

first term of the series is the WBK approximation. Each of the higher terms in turn represents the reflections generated by the preceding term. The expansion is obtained by approximating the potential by a "staircase" potential, which is constant over short regions and changes its value discontinuously between these regions. The method is applied to periodic potentials. By taking the WBK approximation and the first reflection term into account, the zones of the periodic potential can be found in terms of a coefficient which gives the probability that a particle will be reflected in passing through one cell of the periodic potential. A.

530.162

4119. An application of auto-correlation analysis. E. R. KRETZMER. *J. Math. Phys.*, **29**, 179-90 (Oct., 1950).

This paper deals with the interference characteristics of pulse-time modulation systems. The effect of various types of random disturbance of the timing of pulse-edges is studied. Approximate expressions for the average noise level are obtained.

N. L. JOHNSON

530.162

4120. On the first passage time probability problem. A. J. F. SIEGERT. *Phys. Rev.*, **81**, 617-23 (Feb. 15, 1951).

An exact solution for the first passage time probability of a stationary one-dimensional Markoffian random function from an integral equation has been derived. A recursion formula for the moments is given for the case that the conditional probability density describing the random function satisfies a Fokker-Planck equation. Various known solutions for special applications (noise, Brownian motion) are shown to be special cases of our solution. The Wiener-Rice series for the recurrence time probability density is derived from a generalization of Schrödinger's integral equation, for the case of a two-dimensional Markoffian random function. A.

GENERAL MECHANICS . MECHANICS OF SOLIDS 531

531.266.2

4121. Note on Newtonian force-fields. G. BIRKHOFF AND L. BURTON. *Canad. J. Math.*, **1** (No. 2) 199-208 (1949).

Gauss's integral theorem, Poisson's equation and the existence of force components as derivatives of a potential are established under very general conditions for n -dimensional space.

R. A. NEWING

531.382

4122. Magnetically suspended vacuum-type ultracentrifuge. J. W. BEAMS, J. D. ROSS AND J. F. DILLON. *Rev. Sci. Instrum.*, **22**, 77-80 (Feb., 1951).

A centrifuge rotor constructed of steel and Duralumin ST-14 weighing 4.93 kg and having a radius of 65 mm to the centre of the standard centrifuge cell, which contains the material to be centrifuged, is suspended magnetically in a high vacuum (pressure

less than 10^{-5} mm Hg). The rotor is driven to running speed by an air turbine below the vacuum chamber. The turbine is connected to the rotor by a small steel shaft along the axis of rotation and passing through vacuum-tight oil glands into the vacuum chamber. When the rotor reaches operating speed, the shaft is disconnected and the rotor is allowed to coast freely during the sedimentation experiment. This is possible because of the very small deceleration of the rotor (less than a 0.1 rev/sec/hr). As a result the temperature and rotor speed not only can be measured accurately, but can be maintained very nearly constant. The ultracentrifuge has been used both for rates of sedimentation measurements and for sedimentation equilibrium measurements, but is especially suited for the latter. A.

531.396

4123. Motion relative to the surface of the rotating earth. R. H. BACON. *Amer. J. Phys.*, **19**, 52-6 (Jan., 1951).

When an observer moves over the face of the earth, there is a change in both the magnitude and the direction of the apparent acceleration due to gravity. At speeds now becoming attainable, the change is just about observable with modern aircraft navigating instruments. The change consists of two terms—a Coriolis term and a centripetal term. If a particle could be dropped through a vacuum from an aircraft flying a great circle course, the Coriolis deflection of the falling particle, as seen by the airman, would be independent of the aircraft's velocity. A.

531.4

4124. On the smooth reactions of two solid bodies in contact. J. BOUZITAT. *C.R. Acad. Sci., Paris*, **232**, 683-5 (Feb. 19, 1951).

The results originally obtained by Hertz for the distribution of normal pressure and the shape and area of the surface of contact are established by an alternative and more direct method. The resulting distribution of tension in the two bodies near the surface of contact is also discussed.

A. T. PRICE

MECHANICAL MEASUREMENTS 531.7

531.7

4125. New optical precision measuring instruments for the workshop. A. METZ. *Trans. Instrum. Meas. Conf., Stockholm* (1949) 182-5 (1950) *In German*.

A brief illustrated description of new Leitz instruments. These include an instrument for the control of sizes of workpieces, a co-ordinate drilling machine with a precision measuring ocular, a telescope with a magnification of 32 and a range of 1-50 metres, and the "Perflektometer," an instrument for the measurement of end, gap and other gauges. S. WEINTROUB

531.715.1

4126. An interference method for the measurement of microscopic spheres. B. W. WILSON. *Aust. J. Appl. Sci.*, **1**, 235-42 (Sept., 1950).

The classification according to diameter achieved by forcing spheres into a wedge-shaped space and an

interference phenomenon characteristic of very narrow wedge-shaped cells have been utilized to make absolute measurements of sphere diameters between 1 and 15 microns. Two types of cell have been described and the results obtained with a number of closely sized fractions of microscopic spheres have been analysed statistically. A.

531.717.3 : 620.172.222 : 621.317.39

4127. Multi-channel measurement of physical effects by confluent pulse technique with particular reference to the analysis of strain. J. G. YATES, D. H. LUCAS AND D. L. JOHNSON. *Proc. Instn Elect. Engrs, Pt II*, **98**, 109-24 (April, 1951) [Reprint No. 1030].

For abstract see Abstr. 861 (1951).

531.72

4128. The Forster surface measuring instrument. A. METZ. *Trans Instrum. Meas. Conf., Stockholm* (1949) 177-81 (1950) *In German*.

After a brief discussion of the various methods used in surface measuring instruments, the new Forster optical instrument, which employs a feeler pin, moved vertically by an impulsing device in a series of quick jumps from one test position to the next, is described. The pin is a sapphire needle of 2-10 microns point radius, and can make from 50-100 contacts per sec. The instrument is fitted with a motor-driven 35 mm film camera for recording. The magnification is about 2 000 times. It is suitable for calibration and research work, not for general workshop use.

S. WEINTROUB

531.724

4129. A reply to Fu regarding the new method of estimating the surface area of powder. M. MIZUSHIMA. Letter in *J. Chem. Phys.*, **19**, 260 (Feb., 1951). See Abstrs. 3799, 7040 (1950).

531.74

4130. Measurement of angle by interferometry. C. F. BRUCE AND W. A. F. CUNINGHAME. *Aust. J. Appl. Sci.*, **1**, 243-58 (Sept., 1950).

The method used has given a precision of the order of 0.1 sec of arc in angle measurement. The variation in flatness of the existing angle standards and the distortion of the surfaces that occurs in wringing have been immediately observable and measurable to a high precision. The method has shown that the angles of the gauges vary by 1 or 2 sec over their surfaces. The uncertainty in definition of angle is, therefore, of this order and will be still greater when gauges are wrung in combination. Work is proceeding on combinations of gauges in order to calibrate complete sets and to investigate the reliability of an angle made up of a combination of several gauges. A.

531.758

4131. A magnetically compensated vapor density balance. E. W. JOHNSON AND L. K. NASH. *Rev. Sci. Instrum.*, **22**, 240-4 (April, 1951).

A magnetically compensated buoyancy balance is described. This instrument provides precise and continuous indications of gas and vapour densities falling in the range of 0 to 4 g/l. Measurements can be made at temperatures that are freely variable up to 220°C; mildly corrosive vapours can be handled; and the data are automatically corrected for adsorption effects. The long term reproducibility of the

readings is 0.001 g/l. Magnetic compensation is attained by adjusting the current in an external electromagnet until this magnet's interaction with a small permanent magnet sealed in the balance beam restores the beam to a standard null position. The virtually linear relationship between this "restoring" current and the ambient vapour density is established by calibration with a standard substance. High constancy of calibration has been achieved through the use of a special beam suspension which, though extremely friction free, is unaffected by repeated and relatively severe mechanical and thermal shocks. A.

531.78

4132. Measurement of rapidly changing mechanical quantities by means of quartz pickups, photocell pickups and cathode-ray oscillograph. M. NIER. *Trans Instrum. Meas. Conf., Stockholm* (1949) 150-3 (1950) *In German*.

The practical requirements for suitable quartz pickups for the measurement of force and pressure changes of frequencies up to 10⁴ c/s are discussed. A new null method of calibration by applying known balancing pressures to the pickup while in operation is described and a quartz chamber with calibration device suitable for low pressures is illustrated. A similar calibration method and the various arrangements for photocell pickups used for the measurement of rapid displacements and motions of pistons and in pump jets are briefly described. Errors introduced by changes in insulation, in the amplifiers and by mains fluctuations are stated to be practically eliminated by the method.

S. WEINTROUB

531.787 : 616-7

4133. A hypodermic pressure manometer utilizing the bonded wire resistance strain gauge. H. R. BIERMAN AND R. JENKINS. *Rev. Sci. Instrum.*, **22**, 268-89 (April, 1951).

The recent development of the bonded resistance wire strain gauge has led to its use as a device for measuring physiological pressure phenomena. Further application of the strain gauge has been as an instrument for measuring intravascular blood pressures and other pressure phenomena in biology and medicine. A.

531.791 : 539.16.08 : 621.394.64 : 621.318.572

4134. Electromechanical registers as used in radio-active counting systems. A. E. BENNETT. *Electronic Engng*, **23**, 81-5 (March, 1951).

Describes two new electromechanical registers: an escapement type with a max. speed of 70/sec and a motor driven type, with magnetic clutch, having a max. speed of 60/sec.

A. O. STANESBY

531.792

4135. New Johns Hopkins ruling engine. J. STRONG. *J. Opt. Soc. Amer.*, **41**, 3-15 (Jan., 1951).

New procedures of lapping and mounting of ruling engine screws are described. An inherently precise method of generating a dividing head with unmeasurable errors is described. A new design of ruling engine with two screws and with the work reciprocating, is described. This engine resembles a planer whereas the Rowland type engines resemble a tool room shaper. Fanned lines are not produced on the new engine. All components are designed for

immunity to temperature, friction and wear. Gratings of 21 ft focus are currently being ruled 14 400 lines per inch with $\frac{1}{10}\%$ Rowland ghost intensity in the 1st order. The ruled area is $5\frac{1}{8} \times 3\frac{1}{8}$ in. All gratings show 5 components of Hg 5461 in the 2nd order. The gratings are ruled in 67 hr. It is envisioned that grating production can be made adequate to satisfy the needs for gratings without recourse to replicas. The new engine is a pilot model for a larger engine planned for the future.

A.

MECHANICS OF FLUIDS 532

532.123

4136. The tensile strength of benzene. J. J. DONOGHUE, R. E. VOLLRATH AND E. GERJUOY. *J. Chem. Phys.*, **19**, 55-61 (Jan., 1951).

The centrifuge method is described, together with various features which have been incorporated into the procedure to insure uniformity of samples. There is evidence, which is not conclusive, however, that the rupture strength increases as the amount of permanent gas dissolved in the liquid decreases. The highest observed rupture strength, 157 atmosphere, is believed to represent the adhesion strength of the benzene to the walls of a particular tube, and may be much less than the limiting tensile strength of benzene. No evidence for a temperature dependence of the tensile strength has been found, but this result is probably also not representative of the limiting tensile strength of benzene.

A.

532.123 : 532.73

4137. The visco-elastic properties of solutions of rod-like macromolecules. J. G. KIRKWOOD AND P. L. AUER. *J. Chem. Phys.*, **19**, 281-3 (March, 1951).

The general theory of irreversible processes in solutions of macromolecules is employed to investigate the visco-elastic behaviour of solutions of rod-like macromolecules. It is found that rotatory diffusional torques are responsible for three-fourths of the stationary intrinsic viscosity. Under the action of periodic shear waves, the rotatory diffusional contribution to the stress exhibits relaxation phase lag and imparts a rigidity to the solution. As the frequency is increased, the intrinsic viscosity drops to one-fourth of its stationary value and the rigidity modulus increases to an asymptotic value of $3RT/5$ per mole/cm³ of solute.

A.

532.133

4138. Viscosity-temperature dependence. I. WILLIAMSON. Letter in *Nature, Lond.*, **167**, 316-17 (Feb. 24, 1951).

While it is agreed that the existing methods of viscosity-temperature representation are unsatisfactory, it is shown that the formula suggested by Dr. A. V. Brancker [Abstr. 1641 (1951)], namely $\eta(1 - a/T) = b$, does not cover the liquids used by the author. It is pointed out that the main difficulty in the graphical representation of viscosity-temperature relations is the very wide range of magnitudes which the viscosity can assume in a number of liquids, and on any linear scale the majority of the points are

crowded together near the x axis. Writing the equation thus, $\eta = a\eta/T + b$, indicates how it accentuates this trouble since η increases as T diminishes, thus opening out the scale still further.

T. C. TOYE

532.137

4139. A continuous flow, high temperature viscosimeter for drilling muds. R. W. HOEPEL. *Rev. Sci. Instrum.*, **22**, 248-53 (April, 1951).

A continuous-flow tube viscosimeter is described which permits determination of viscosities and gel strengths of abrasive thixotropic fluids at temperatures up to 250°F. Provision is made for the introduction of treating chemicals into the closed system, while under pressure, without interrupting fluid flow. The new instrument employs a special rubber tube pump which maintains constant flow under various pressures and is unaffected by abrasive materials. Flow characteristics of the pump are discussed, and tube and Stormer viscosimeter data are compared.

A.

532.2 : 536.7 : 530.162

4140. On the statics of fluids. J. E. VERSCHAFFELT. *Bull. Acad. Roy. Belg. Cl. Sci.*, **36** (No. 11) 823-35 (1950) In French.

An attempt to develop a complete theory of the internal mechanical equilibrium of fluids taking account of all the forces able to exert any action. It is based on the author's thermo-mechanical theory of transport phenomena.

F. E. HOARE

532.516 : 539.893

4141. Lubrication at extreme pressures with mineral oil films. O. H. CLARK, W. W. WOODS AND J. R. WHITE. *J. Appl. Phys.*, **22**, 474-83 (April, 1951).

Intact mineral oil films at average pressures ranging from 86 000 to 215 000 lb/in² and at high rates of shear have been obtained using a bearing consisting of the contact area between crossed axis steel cylinders. Intact films have also been maintained at low rates of shear and lower pressures using a bearing consisting of a sphere in a spherical shell. The lubricating films possess the shearing properties of plastic solids, a fact which is consistent with solidification observations reported in the literature of high-pressure viscometry. In the crossed cylinder bearing the high film pressures required for lubrication are induced by hydrodynamic forces. Such forces can be very large as a result of the rapid increase in viscosity incurred by mineral oils under increasing pressure. The observation of complete mineral oil lubrication at such extreme pressures resulting from known bulk properties, namely, viscosity increase and solidification under pressure, suggests that these properties are sufficient to account for practical mineral oil lubrication.

A.

532.517

4142. On the viscosity of liquid hydrocarbon mixtures. F. W. LIMA. Letter in *J. Chem. Phys.*, **19**, 137-8 (Jan., 1951).

532.517

4143. Some experiments in viscous fluid flow. K. RIESS AND J. E. BAUDEAN. *Amer. J. Phys.*, **19**, 116-21 (Feb., 1951).

The motion of a viscous fluid contained between two coaxial cylinders is described. A speed criterion,

although derived assuming the cylinders to have infinite length, is confirmed for the case of cylinders of finite length. The optical property of visibility of planes of equal shear in the liquid under steady flow is used to study glycerine-water and castor oil-ethyl alcohol solutions, as well as several pure oils. An explanation of the visibility of these lines is proposed. An adaptation to the measurement of viscosities is suggested. A.

532.517 : 539.217

4144. Fluid flow through porous metals. L. GREEN, JR. AND P. DUWEZ. *J. Appl. Mech.*, **18**, 39-45 (March, 1951).

A method is outlined for correlating experimental data obtained in studies of the flow of gases and liquids through porous metals. The correlation is based upon the suggestion of Forcheimer that the pressure gradient attending the flow of a liquid through a porous medium can be expressed as a function of flow rate by a simple quadratic equation. An equation of this type defines two length parameters necessary for characterization of a porous structure and permits a general definition of the Reynolds number for a structure of arbitrary complexity. A.

532.517.4

4145. Difference between turbulence in a two-dimensional fluid and in a three-dimensional fluid. T. D. LEE. Letter in *J. Appl. Phys.*, **22**, 524 (April, 1951).

532.570.8

4146. An electromagnetic flowmeter for transient flow studies. J. S. ARNOLD. *Rev. Sci. Instrum.*, **22**, 43-7 (Jan., 1951).

An adaptation of the electromagnetic flowmeter has been made for the observation of transients in liquid flows. The device responds to flow transients of 0.001 sec duration, and is not affected by ambient pressure changes or the velocity profile of the liquid in the conduit. The effects of fluid resistivity on the instrument are noted. A.

532.593

4147. On the wave motion of the sea at a beach. M. ROSEAU. *C.R. Acad. Sci., Paris*, **232**, 479-81 (Feb. 5, 1951) *In French*.

The small irrotational movements of the sea on a beach are expressed by an equation of the form $\Phi = e^{i(kz + \sigma t)}\phi(x, y)$, of which two independent solutions are obtained. A special case treats the problem of a dock of infinite depth.

E. M. FOURNIER D'ALBE

MOLECULAR THEORY OF LIQUIDS 532.7

532.7

4148. On the distribution function in phase space, with application to the statistical theory of liquids. E. IKENBERRY. *J. Chem. Phys.*, **19**, 467 (April, 1951).

A simple form for the expansion of the distribution function in phase space, by means of modified Hermite polynomials, is set up. Expressions for the density,

temperature and the components of the mass current, of the strain tensor, and of the heat current, in terms of the coefficients in the expansion, are obtained. A simple method for obtaining the infinite set of integro-differential equations imposed upon the coefficients in the expansion of the distribution function by the Gibbs' principle of conservation of density-in-phase is outlined. Results obtained for the dissipative processes of heat conduction and of viscosity in liquids are summarized. A.

532.7 : 536.7

4149. Note on the free volume of a liquid. Y. NOMURA. *Sci. Rep. Res. Inst. Tôhoku Univ., Ser. A*, **1**, 149-52 (Oct., 1949).

Hildebrand's approximation for liquids [*Phys. Rev.*, **34**, 984 (1929)] is combined with Clausius's virial theorem to obtain an equation of state (i) for a liquid. i is shown to hold fairly well for ethyl ether. i is then combined with the partition function for a liquid to obtain an expression for free volume v_f . Comparison with numerical data shows that for ether, the values of v_f (at different pressures) so obtained differ considerably from those calculated by Eyring's expression [*J. Phys. Chem.*, **41**, 249 (1937)] presumably because the latter ignores the dependence of the size of a molecule on molar volume. S. J. GREGG

532.7 : 536.7

4150. On the measurement of variations in internal energy by ultrasonic methods. Contribution to the study of the structure of liquids. F. DANUSSO. *Atti Accad. Naz. Lincei (R.C. Cl. Sci. Fis. Mat. Nat.)* **9**, 351-7 (Dec., 1950) *In Italian*.

The first and second laws of thermodynamics are used to deduce a formula valid for homogeneous and isotropic liquids in the adiabatic and reversible state, and expressing the variations in internal energy with respect to pressure, at const. entropy, as a function of the pressure, vol. and density of, and of the ultrasonic velocity in the liquid. Values of the molecular internal energy (in cal 10^{-6} /mole atm.) are tabulated for 34 pure organic liquids (hydrocarbons, alcohols and ketones) and range from 18 for H_2O , to 435 for 2,2'-dimethyl pentane (temp. coeff. $0.008 + 0.010^\circ K$). J. GRANT

532.7 : 537.531 : 535.42

4151. An atomic distribution function. R. H. KERR AND J. H. LUND. *J. Chem. Phys.*, **19**, 50-4 (Jan., 1951).

A simple form for the radial atomic distribution function for a monatomic liquid, involving the interatomic potential function of two atoms in the liquid, is developed. Assuming the potential function to be of the form $(\lambda/r^n) - (\mu/r^9)$ and arbitrary choices for μ , the theoretical distribution function is fitted to the left-hand side of the first peak of the experimental distribution curves of liquid A and liquid Hg. Satisfactory values of n and potential well depths for these two liquids indicate the approximate validity of the derived radial atomic distribution function. A.

532.712 : 537.36

4152. Some newer experimental results on the osmosis in alternating electric fields. Z. LÁSZLÓ. Letter in *J. Chem. Phys.*, **19**, 133-4 (Jan., 1951).

See Abstr. 6296 (1950).

532.72 : 534.321.9

4153. Investigation on the effect of ultrasonics on diffusion. C. HAGEN, H. H. RUST AND F. LEBOWSKY. *Naturwissenschaften*, **38** (No. 1) 5-6 (1951) In German.

No specific effect could be detected in experiments based on osmosis. The interference due to heating caused by the absorption of ultrasonic energy was eliminated.

F. LACHMAN

532.72 : 541.126

4154. Wall reactions and diffusion in static and flow systems. R. GOMER. *J. Chem. Phys.*, **19**, 284-9 (March, 1951).

The distribution of radicals at steady state has been computed for simple systems subject to heterogeneous and homogeneous reactions. Sample distributions are given. Expressions for two non-steady-state situations are derived for the case of a 1st-order gas and 1st- or 2nd-order wall reaction. The effect of expansion and longitudinal diffusion on radical concentration in flow systems is discussed. Equations governing the former are derived and a method of estimating its effect rapidly is given. Expressions giving the upper limit of the latter are presented. It is shown that expansion may simulate a 1st-order reaction, and may be of considerable importance in fast flow.

A.

532.72 : 541.64

4155. Theory of high polymer solutions. T. NAKAJIMA. *Sci. Rep. Res. Inst. Tôhoku Univ.*, Ser. A, **2**, 396-404 (April, 1950).

The abnormal natures of the thermodynamical properties of the high polymer solutions have been studied theoretically. It was shown that by introducing the effective co-ordination number for the segments and the effective concentrations for the polymers, these solutions can be treated as the usual regular solutions. In addition, some remarks on the various models of these solutions were discussed.

A.

532.73 : 538.22

4156. Nuclear spin relaxation studies in dilute sodium-liquid ammonia solutions. R. NEWMAN AND R. A. OGG, JR. *J. Chem. Phys.*, **19**, 214-17 (Feb., 1951).

The nuclear spin relaxation times of the protons in dilute solutions of Na in liquid NH_3 have been measured at 30 Mc/s over the room-temperature/dry-ice range. The data can be interpreted on the basis of an associative equilibrium existing between paramagnetic and diamagnetic solute species. This is in agreement with the results of the conventional magnetic susceptibility measurements. The paramagnetic component of the solutions seems to be about one-tenth as effective as a cupric ion in inducing nuclear relaxation.

A.

532.73 : 541.64

4157. Theory of high polymer solutions (the dumbbell model). A. ISIHARA. *J. Chem. Phys.*, **19**, 397 (April, 1951).

Following the theories of McMillan, Mayer and Zimm, and extending the previous theories of the author, the second virial coefficient A_2 for high polymer solutions of the dumbbell model is calculated.

The results are rigorous within the approximation of rigid-body potential. A_2 varies smoothly with l/R , where R is the radius of spheres of the dumbbell and l is their separation. Based on the present results, comparisons between the gas and the lattice theories are made.

A.

532.73-1

4158. Erratum: On the stability of gas bubbles in liquid-gas solutions. P. S. EPSTEIN AND M. S. PLESSET. Letter in *J. Chem. Phys.*, **19**, 256 (Feb., 1951).

See Abstr. 2428 (1951).

532.73-1

4159. Comment on "Gas bubbles in solutions." F. C. ROESLER. Letter in *J. Chem. Phys.*, **19**, 512 (April, 1951).

See Abstr. 2428 (1951). Theoretical. The rate of growth of bubbles is considered: (a) during appreciable translatory motion due to buoyancy, and (b) in a strongly turbulent liquid.

W. C. A. HUTCHINSON

532.782

4160. Some behaviours of supercooled liquid at low temperatures. E. KANDA, A. ÔTSUBO AND T. HASEDA. *Sci. Rep. Res. Inst. Tôhoku Univ.*, Ser. A, **2**, 9-15 (Feb., 1950).

Specific heats of isobutyl alcohol were measured at the temperatures between -170°C and room temperature. The values between these temperatures varied markedly depending upon the thermal histories of the sample. Beside the $C_p \sim T$ curves in the liquid and crystalline states, curves with large humps were obtained in some cases which were thought to show crystallization and fusion in the supercooled state. The experimental results and considerations were compared with the viscosities of the samples in the supercooled state which indicated some effects due to clustering of molecules. These experimental results were explained by crystal nucleus models and growth into crystallites. This behaviour was also shown in light-scattering experiments.

A.

MECHANICS OF GASES 533

533.15

4161. Effect of pressure on thermal diffusion in gases. E. W. BECKER. Letter in *J. Chem. Phys.*, **19**, 130-1 (Jan., 1951).

533.16 : 534.37

4162. Phenomenological theories of bulk viscosity. HOFF LU. *Chin. J. Phys.*, **7**, 365-75 (Sept., 1950).

A differential equation relating pressure and compression is formulated, corresponding to a response to applied isotropic pressure which is partly instantaneous and partly delayed due to bulk viscosity. On the basis of this type of behaviour in compression and Maxwellian visco-elastic behaviour in shear, the coefficient of sound attenuation is calculated. The equations of viscous flow are generalized to include the effect of bulk viscosity as well as shearing viscosity.

J. G. OLDROYD

533.5

4163. On the method of determining the best operating condition of a fractionating oil diffusion pump. T. HIBI AND K. ISIKAWA. *Sci. Rep. Res. Inst. Tôhoku Univ., Ser. A*, **1**, 261–5 (Oct., 1949).

The best operating conditions of Hickman's pump are usually indicated by the appearance of an oil ring above the boiler jet. The authors show that the oil ring corresponds to the highest final vacuum only if the fore-vacuum is satisfactory (1 to 2×10^{-3} mm Hg) and suggest that measurement of the oil temperature is more reliable. On plotting oil temperature against current, the point of inflection of the curve corresponds to that current which gives the highest final vacuum and thus the best operating conditions.

G. WITTENBERG

533.5

4164. A greaseless gas flow valve. R. E. HONIG. Note in *Rev. Sci. Instrum.*, **21**, 1024 (Dec., 1950).

533.5

4165. Reverse separation in fractionation pumps. K. HICKMAN. *Rev. Sci. Instrum.*, **22**, 141–6 (March, 1951).

Measurements by Trevo and the writer, to be published shortly elsewhere, have shown that the relative volatilities of mixtures of liquids increase surprisingly at low rates of distillations. A consequence is that organic liquids release volatiles into high-vacuum apparatus more readily than would be deduced from measurements made at usual pressures of, say, 1–100 microns. The composition of condensate in an oil-filled diffusion pump is found to be a function of position in the pump, the lightest constituents straying preferentially to the high-vacuum end. As an example, Octoil contaminated with less than 1% of butyl phthalate in the last boiler of a 3-stage pump was found to pass vapour through the high-vacuum entrance as though the boiler had contained 27% butyl phthalate. To epitomize the situation, a vapour pump is a specialized form of still with two exits. The intention of the designer, expressed in the geometry of the pump, is to force the lighter molecules to one exit but molecular perversity causes them to wander to the other.

A.

533.6.011

4166. The problem of the detached shock wave for the case of revolute flows. H. CABANNES. *C.R. Acad. Sci., Paris*, **232**, 686–7 (Feb. 19, 1951) *In French*.

A body of revolution about an axis Ox is placed in a uniform gas stream parallel to Ox , of which the Mach number is > 1 . A detached shock wave given by the equation $x = (r^2/2R) + \lambda r^4/4R^3$, where x is the distance from the vertex of the wave to Ox , R is the radius of curvature of the wave at its vertex, and λ is a dimensionless parameter, being produced in the stream, the problem posed is to determine first of all the flow behind the shock wave (Cauchy's problem), and therefrom the form of the obstacle. According to the form adopted for the wave the form of the obstacle may be either solid or hollow. In the former case, several shock waves, corresponding to the same obstacle, can exist for a specified upstream velocity. The theoretical results agree to

within 10% with experimental results obtained by Herberle, Wood and Gooderum. J. S. G. THOMAS

533.6.011

4167. Compressible flows. J. B. KELLEY. *Amer. J. Phys.*, **19**, 237–43 (April, 1951).

A brief exposition (descriptive rather than quantitative) is given of some of the common phenomena of compressible flow. A graphical representation of a point source moving through a fluid at various velocities from subsonic to supersonic is given and described. There is also a description with sketches of the principal optical methods of wind-tunnel testing for compressible flows. A number of actual test photographs is included which show the types of picture obtained by the various test methods and which also shows the formation of shock and Mach waves.

A.

533.6.011.3

4168. The generality of mixed gas flow. M. M. MUNK. Letter in *J. Appl. Phys.*, **22**, 524 (April, 1951).

533.6.011.5 : 534.222.2

4169. An investigation of the curvature at the apex of the attached shock-wave in axially-symmetric flow. H. CABANNES. *C.R. Acad. Sci., Paris*, **232**, 481–3 (Feb. 5, 1951) *In French*.

Expressions for gas-velocity, density and pressure behind the shock-wave are developed as a power series in r/R (where r is the distance from the apex and R the radius of curvature of the shock-wave). The zero-order terms in the series are the gas-velocity, density and pressure distributions for axially-symmetric flow around a cone; equations are derived which define the first-order terms. The condition of contact between a streamline and the obstacle is used, together with the zero and first-order terms of the power series, to derive the ratio of the curvatures of the shock-wave and the obstacle at its apex, when the gas-flow behind the shock is supersonic.

A. SCHOFIELD

533.6.013.22

4170. On the spectrum of isotropic temperature fluctuations in an isotropic turbulence. S. CORRSIN. *J. Appl. Phys.*, **22**, 469–73 (April, 1951).

The 1- and 3-dimensional spectral equations for a field of isotropic temperature fluctuations in an isotropic turbulence are derived from the correlation equation. Then, except for the degenerate case of simple conductive decay, stationary fluctuation fields are postulated. Largely by dimensional reasoning and some simple postulates, forms of the temperature fluctuation power spectrum for particular wave number ranges are deduced and are compared with the results of previous analyses giving corresponding segments of the velocity spectrum. Finally, the relative "effective cut-off" wave numbers of the 2 spectra are compared in terms of the fluid Prandtl number.

A.

533.6.013.22

4171. Decay of spectral components in isotropic turbulence. H. SATO. Letter in *J. Appl. Phys.*, **22**, 525 (April, 1951).

MOLECULAR THEORY OF GASES 533.7

VIBRATIONS . ACOUSTICS 534

4172. On the second virial coefficient of gas mixtures. R. J. LUNBECK AND A. J. H. BOERBOOM. *Physica*, **17**, 76–80 (Jan., 1951).

Information on the interaction between different molecules can be derived from the temperature dependence of the compressibilities of gas mixtures. An alternative method is to measure the volume change on mixing two gases, but this method assumes knowledge of the virial coefficients of the pure gases. For both methods the required accuracy is so high that at present no reliable comparison can be made of the intermolecular energy of different molecules with the field of identical molecules. Several empirical rules have been proposed to estimate the interaction between different molecules from the forces acting between identical particles. It is shown that quantities calculated with the help of these rules are in fair agreement with experimental data.

A.

4173. Transport properties of gases with a square-well molecular interaction potential. E. M. HOLLERAN AND H. M. HULBURT. *J. Chem. Phys.*, **19**, 232–41 (Feb., 1951).

The kinetic theory cross-section integrals are calculated for the square-well molecular potential model. Parameters are determined for light gases from viscosity measurements and are used to reproduce viscosity data for pure gases and binary mixtures. Comparison is made between these parameters and those found from compressibility data and other transport properties. Different sets of parameters are apparently required for each transport property in order to account for the experimental results. The thermal diffusion constant for this model is a function of temperature and one other parameter. Excellent reproduction of the neon isotope data is obtained, and predictions of the qualitative behaviour of the thermal diffusion ratio are made.

A.

4174. Born and Green's theory of imperfect gases. G. S. RUSHBROOKE AND H. I. SCOINS. Letter in *Nature, Lond.*, **167**, 366–7 (March 3, 1951).

533.75 : 539.11

Second virial coefficient of water vapour. See Abstr. 4571

533.77

4175. The free volume for rigid sphere molecules. R. J. BUEHLER, R. H. WENTORF, JR., J. O. HIRSCHFELDER AND C. F. CURTISS. *J. Chem. Phys.*, **19**, 61–71 (Jan., 1951).

The size and shape are quite different from that of the inscribed spheres which correspond to the Lennard-Jones and Devonshire approximation. At high densities the equation of state obtained from the exact treatment agrees well with the Eyring or Lennard-Jones and Devonshire equation. When the specific volume is greater than twice the cube of the collision diameters, the molecules are no longer confined to cages formed by neighbouring molecules. At these low densities the free volume concept is ambiguous. The equation of state depends upon the shape and orientation of the cells with respect to the lattice positions of the molecules.

A.

- 534.01
4176. The oscillations of magnetic suspensions. K. MILLSAPS AND J. C. MCPHERSON. *J. Appl. Phys.*, **22**, 429–32 (April, 1951).

The oscillations of a magnetic suspension between two equal poles are formulated in terms of a non-linear ordinary differential equation of the 2nd order that may be integrated in terms of elliptic integrals of the 2nd kind. The case of unequal poles is treated by an analogous procedure involving a Legendre reduction. The further refinement of viscous damping is treated by numerical integration, and the relaxation times are found by exponential extrapolation.

A.

534.113

4177. The characteristic frequencies of cylindrical steel rods. R. ADOLPH, H. O. KNESER AND I. SCHULZ. *Ann. Phys., Lpz.*, **8** (No. 3–4) 99–104 (1950) In German.

The frequencies of cylindrical steel rods were determined under conditions of torsion, axial tension and compression, and bending, to an accuracy of 10^{-4} at frequencies up to where the wavelength becomes approximately equal to the diameter of the rod. The velocity of torsional waves was not affected by the ratio of diameter (d) to wavelength (λ) up to $d/\lambda = 0.5$, but the velocity of longitudinal waves began to decrease at $d/\lambda = 0.05$ and fell by $1\frac{1}{2}\%$ at $d/\lambda = 0.3$. This latter result agreed with a theoretical curve based on a value of Poissons' ratio of 0.283. The velocity of waves of bending increased with d/λ in a non-linear manner, the increase of velocity with increase of d/λ decreasing with increase of d/λ . The frequency of bending vibrations increased with increase of d/λ to attain a peak value at $d/\lambda = 0.4$ and then fell sharply, the results being in good agreement with values computed from Goens' formula.

A. C. WHIFFIN

534.14 : 548.734.3

New method of forming powder striations. See Abstr. 3202

534.141

4178. A mechanical shake testing stand [for vibrations] up to 300 c/s with frequency and amplitude continuously variable during operation. W. BEHRMANN. *Trans Instrum. Meas. Conf., Stockholm* (1949) 114–22 (1950) In German.

Various forms of German commercial mechanical, electromagnetic and electrodynamic vibration test stands are briefly described, followed by a detailed discussion of the theory and construction of the new 300 c/s Askania model. It is a 3-, though essentially a 2-, mass vibrational system. The masses are linked together by 2 springs in parallel, the one fixed and the other attached to the exciting mechanism which consists of motor-driven eccentric crank. Suitable devices for the measurement of the frequency and amplitude of the vibrations are discussed.

S. WEINTROUB

534.152

4179. Ultrasonography. P. J. ERNST. *J. Acoust. Soc. Amer.*, **23**, 80–3 (Jan., 1951).

It is shown that with or even without ultrasonic lenses or other devices for the concentration of ultrasonic energy, images can be made by ultrasonics on

photo-sensitive emulsions. Several of the first ultrasonographs, as these images are called, are reproduced and some potential fields of application of the new technique are mentioned. A.

534.2/8

- 4180. Fundamentals of acoustics.** L. E. KINSLER AND A. R. FREY. *London, Chapman and Hall* (1950) 516 pp.

This is a class-room textbook giving the fundamental principles of the generation, transmission and reception of acoustic waves. The first 9 chapters analyse the various types of vibration of solid bodies and the propagation of sound waves through fluids. In this part of the book studies are made of simple harmonic motion, the vibration of strings, bars, membranes and plates, plane and spherical waves, transmission phenomena, resonators and filters, and absorption. The remaining 7 chapters cover a limited number of applications of acoustics, it being intended to stress the close association between acoustics and communications engineering. In this part of the book, the chapters include direct radiation loudspeakers, horn type speakers, microphones, human hearing, architectural acoustics, underwater acoustics, and ultrasonics. Mention is frequently made of the point that the mathematical formulation of many acoustical problems is similar to that of the transmission of a.c. through lines and networks, and much use is made of electrical analogues. A. C. WHIFFIN

534.21

- 4181. Guided sound waves.** Y. ROCARD. *C.R. Acad. Sci., Paris*, **232**, 485-7 (Feb. 5, 1951) *In French*.

Discusses the propagation of sound in an indefinite cylinder of radius a constituted by a medium in which the velocity of sound is c_1 , whilst outside the radius a is a medium in which the velocity of sound is c . It is shown that, provided $c_1 < c$, longitudinal waves are propagated along the oz axis inside the radius a without producing appreciable radial propagation in the medium c —the energy being mainly confined in the cylinder of radius a . This applies whether the axis of the cylinder is straight or curved. A. B. WOOD

534.22

- 4182. Improved methods for measuring ultrasonic velocity.** G. W. WILLARD. *J. Acoust. Soc. Amer.*, **23**, 83-93 (Jan., 1951).

Some improved sound wave interference methods for measuring the longitudinal and transverse ultrasonic velocity in opaque as well as transparent solids may be simply carried out by using the ultrasonic light-diffraction system (as arranged for making sound beams visible on a screen). The sonic unit of the system is arranged to produce two individual travelling-wave sound beams, by use of two generators or by splitting a single beam. Three simple arrangements are described in detail. Advantages of the improved methods are simple preparation of test specimen, directness and simplicity of measurement and calculation, good accuracy, low sonic power requirements. A table of measured velocities (and attenuations) in two metals and in numerous plastics and polymers show the wide range of materials that may be measured by the new interference methods. A.

534.22/23

- 4183. Sound velocity and sound absorption in the critical temperature region.** W. G. SCHNEIDER. *Canad. J. Chem.*, **29**, 243-52 (March, 1951).

The velocity and absorption of ultrasound (600 kc/s) has been measured throughout the critical temperature region of SF_6 . Measurements were carried out for the coexisting liquid phase and vapour phase below T_c , and for the supercritical gas, and simultaneously, observations of the meniscus behaviour in the neighbourhood of T_c were made. The sound velocity for both liquid and vapour phases below T_c decreased with increasing temperature and became equal at T_c , the velocity at this point being 121.5 m per sec. In the temperature range from 0.6° below T_c to T_c the velocity in the vapour was greater than that in the liquid. A very high absorption of sound was observed, having a maximum value at T_c and extending over a temperature range of approximately 1°. In the temperature range from T_c to 0.6° below T_c , the absorption in the liquid phase was greater than that in the vapour. A.

534.222.2 : 533.7

- 4184. The thickness of shock fronts in argon and nitrogen and rotational heat capacity lags.** E. F. GREENE, G. R. COWAN AND D. F. HORNIG. *J. Chem. Phys.*, **19**, 427 (April, 1951).

Shock front thicknesses in A and N have been measured at Mach numbers of approximately 1.12, 1.28 and 1.40 by the reflectivity method. These thicknesses are significantly greater than predicted by Thomas and demonstrate the need for an improved theory which will cover the whole range of shock strengths. Reflectivity measurements have also been used to detect distortions of shock fronts in N_2 owing to the lag of the rotational heat capacity. About 20 collisions are required for the rotational relaxation of N_2 at room temperature. A.

534.23

- 4185. Attenuation in a rectangular slotted tube of (1, 0) transverse acoustic waves.** H. E. HARTIG AND R. F. LAMBERT. Letter in *J. Acoust. Soc. Amer.*, **23**, 111 (Jan., 1951).

534.23

- 4186. Principle and apparatus for measuring the acoustic transmission through samples of a partition.** M. KOBRYNSKI AND A. NEYRON. *Ann. Télécommun.*, **6**, 34-42 (Feb., 1951) *In French*.

The technique described is for automatic recording of transmission curves through panels 1 m square under conditions of uniform sound pressure on one of the faces of the panel, the other being coupled to a sound-absorbent cabin. Loudspeakers are used as sound source and electrostatic microphones with logarithmic amplifiers as receivers. G. F. HODSMAN

534.23

- 4187. Ultrasonic absorption in normal- and para-hydrogen.** A. VAN ITERBEEK AND L. VERHAEGEN. Letter in *Nature, Lond.*, **167**, 477-8 (March 24, 1951).

534.23

- 4188. Ultrasonic absorption in liquids.** C. J. MOEN. *J. Acoust. Soc. Amer.*, **23**, 62-70 (Jan., 1951).

A reverberation method has been used to measure the absorption of sound at frequencies down to

140 kc/s in a number of liquids of widely different properties. For glycerol the experimental result agrees well with that predicted by classical theory. For benzene and water good agreement is found with the values calculated using the modified theory employing the values of second viscosity determined by Liebermann. The absorption in CS_2 agrees well with Ouang's result. For these 4 liquids the absorption is found to be proportional to the square of the frequency, but results indicate that toluene has a relaxation frequency of the order of 10^5 sec^{-1} . The reverberation method is especially useful at the lower ultrasonic frequencies, where longer wavelengths and lower absorption render methods used at higher frequencies less reliable or unusable. A.

534.23

4189. Ultrasonic absorption measurements in aqueous solutions of magnesium sulfate. M. C. SMITH, R. E. BARRETT AND R. T. BEYER. *J. Acoust. Soc. Amer.*, **23**, 71-4 (Jan., 1951).

Experimental values are reported for the sound absorption coefficients in aqueous solutions of MgSO_4 over the frequency range 3 to 43 Mc/s. Measurements were made by an electrical method at the lowest frequency and by the pressure balance method at higher frequencies (12-43 Mc/s). Absorption coefficients are reported as a function of frequency, concentration and temperature. An excess absorption (relative to water) is found at the higher frequencies which cannot be interpreted by the present theory. A.

534.23

4190. Ultrasonic absorption of glycerin in the liquid and vitreous state. T. A. LITOVITZ. *J. Acoust. Soc. Amer.*, **23**, 75-9 (Jan., 1951).

The ultrasonic absorption of an associated liquid, glycerin, has been measured, in the liquid and vitreous state, at 31 Mc/s. The value of absorption found exceeds the theoretical value at high temperatures by a factor of 2.1. This indicates that both compressional and shear viscosity contribute to the absorption process. When the liquid was cooled, a peak in the absorption was found at -6.5°C ; and at still lower temperatures the absorption fell to considerably lower than classical values. The appearance of a peak in the absorption experimentally verifies the fact that both compressive and shear viscosity are associated with a relaxation phenomenon. The relaxation times for the two processes are of the same order of magnitude, and the same is true of the activation energies. A.

534.23

4191. A modification of the box method of determining relative sound absorption coefficients. C. B. BOENNING, S. F. HUBER AND T. MARINER. Letter in *J. Acoust. Soc. Amer.*, **23**, 114-15 (Jan., 1951).

534.23 : 532.12

4192. Volume viscosity and compressibilities from acoustic phenomena. HOFF LU. *J. Acoust. Soc. Amer.*, **23**, 12-15 (Jan., 1951).

A phenomenological theory of volume viscoelasticity is formulated, resulting in an equation recently used by Hall. Application of this equation to the dispersion and absorption of sound in fluids is extended to the whole range of frequencies. Results

of calculations of the volume viscosity and the instantaneous and relaxational compressibilities for gases and liquids from certain available absorption data are given. The bearing of this theory on the classical theory of hydrodynamics is pointed out. A.

534.23 : 535.41

4193. A hot-wire ultrasonic interferometer and its application to vapors. K. MATTA AND E. G. RICHARDSON. *J. Acoust. Soc. Amer.*, **23**, 58-61 (Jan., 1951).

A fixed path ultrasonic interferometer for use in vapours is described, in which the stationary wave system between the quartz source and the reflector is explored by a travelling hot-wire. The hot-wire is calibrated for its change of resistance in terms of velocity-amplitude in the ultrasonic wave system. A correction is made for diffraction of the ultrasonic beam. In this apparatus wavelength and absorption measurements are made in ether, ethylene, benzene, carbon disulphide and acetaldehyde vapours. All show an absorption considerably greater than the theoretical values based on the Stokes-Kirchhoff equations. A.

534.231

4194. Experimental determination of acoustic wave fronts. P. TAMARKIN, G. L. BOYER AND R. T. BEYER. *J. Acoust. Soc. Amer.*, **23**, 7-11 (Jan., 1951).

An apparatus for measurements in water at frequencies in the vicinity of 1 Mc/s. The sound waves are radiated by a piezoelectric crystal and are picked up by a movable microphone. The voltage output from the microphone is compared in phase with the voltage feeding the piezoelectric source, by means of a phase discriminator. The signal at the microphone is due both to the transmitted acoustic wave and a stray electric signal. These two are combined in the microphone in such a way as to produce a full wavelength modulation in the resultant signal. A wave front in the sound wave is then traced by moving the microphone along such a line or surface as will cause the phase discriminator to indicate constant phase difference. A mathematical analysis of the problem is given. Time required for measuring wave fronts is reduced to about one-third that previously needed. A.

534.231 : 621.395.623.7

4195. A regulator for sound field strength. P. RIETY. *Ann. Télécommun.*, **6**, 43-8 (Feb., 1951) In French.

A microphone, monitoring the field strength in front of the loudspeaker, is connected to an amplifier and a biased double-diode detector, the smoothed output of the latter controlling the gain of the main amplifier feeding the loudspeaker. The control is effective over 20 c/s to 15 Kc/s and over a loudspeaker response range $> 30 \text{ db}$, a graph showing a typical output controlled within a range of 4 db. The speed of response allows the audio spectrum to be covered in 2 min. F. F. ROBERTS (R)

534.232

4196. Effects of a finite circular baffle board on acoustic radiation. T. NIMURA AND Y. WATANABE. *Techn. Rep. Tôhoku Univ.*, **14** (No. 2) 79-93 (1949).

A theoretical paper in which is derived the general equation which represents the field of velocity potential due to a double-ended vibration of an oblate

spheroid of the first order (the two ends vibrating like a piston along the axis of rotation). The directivity and total power radiated by such an oscillator in a baffle board are determined. The following conclusions are reached: the baffle diameter must be about one-half the wavelength of the lowest required frequency; directivity is not much improved by using a large baffle; the total radiated power is much increased by the use of only a small baffle; at low frequencies the total radiated power is varied greatly by slight changes of frequency.

A. B. WOOD

534.232

4197. On the acoustic folded horns. S. TANAKA. *Sci. Rep. Res. Inst. Tôhoku Univ., Ser. A*, **1**, 243–8 (Oct., 1949).

Two different types of folded horn (“re-entrant” and “mushroom”) are described. These horns have previously been constructed and experimentally tested. Details of these tests and an approximate theory are given.

A. B. WOOD

534.232

4198. The piston source at high frequencies. A. O. WILLIAMS. *J. Acoust. Soc. Amer.*, **23**, 1–6 (Jan., 1951).

For a circular plane piston of radius a , producing an ultrasonic beam with propagation constant k (or $2\pi/\lambda$), an expression is derived for the velocity potential or the acoustic pressure, averaged with respect to magnitude and phase over a “measurement circle” equal in area to the piston and centred in the beam. The expression should be highly accurate for $ka \geq 100$, at distances z from the source governed by $(z/a)^3 \gg ka$. It agrees well with results computed, in another way, by Huntington, Emslie and Hughes. The assumption that relatively near the source there is a collimated beam of plane waves is shown to be not very accurate; the averaged pressure falls off monotonically over all distances considered. The velocity potential at the rim of the “measurement circle” is also computed, and compared with the plane wave assumption.

A.

534.232

4199. Variable resonant frequency crystal systems. W. J. FRY, R. B. FRY AND W. HALL. *J. Acoust. Soc. Amer.*, **23**, 94–110 (Jan., 1951).

A general analysis of variable resonant frequency crystal systems which utilize liquid media as backing is presented. Formulae are obtained for evaluating the effect of different geometries of backing on the resonant frequencies of the system. The various loss factors associated with such a system are related to the measurable quantity, the quality factor. The observed operating characteristics of a variable resonant system which covers a two-to-one frequency band (40 kc/s to 80 kc/s) are presented. The results of an experimental comparison of such a system with fixed resonant frequency systems for generation of ultrasound in liquid media are given. The theory is used to correlate the experimental observations.

A.

534.232 : 616–7

4200. A wide range mechano-electronic transducer for physiological applications. S. A. TALBOT, J. L. LILIENTHAL, JR., J. BESER AND L. W. REYNOLDS. *Rev. Sci. Instrum.*, **22**, 233–6 (April, 1951).

Physiological applications and technical limitations

of the RCA 5734 mechano-electronic transducer tube are discussed. A variable protecting mount adapts this tube to full-scale ranges of force from 5 g to 2.5 kg or more with a 5 V swing on all ranges. Fundamental resonance frequency varies linearly with the range, from 40 to 300 c/s. Amplitude distortion is small and restricted to small deflections. Frequency and phase distortion depend on the driving tissue but are small for myographic phenomena whose highest harmonic is generally around 15 c/s. Adaptation of the 5734 tube to ballistocardiography (1μ to 10μ swing) is also shown.

A.

534.232 : 621.396.611.21

4201. Design of variable resonant frequency crystal transducers. W. L. HALL AND W. J. FRY. *Rev. Sci. Instrum.*, **22**, 155–61 (March, 1951).

Design considerations involved in the development of low-loss, continuously variable, resonant frequency crystal transducers are discussed. A description of such a system employing liquid Hg as a backing of continuously variable dimensions is presented. The important aspects—tight coupling of the crystal and Hg backing, and decoupling of the crystal and Hg from the supporting structure—are considered in detail. Construction procedure on a unit to cover the frequency range 40 to 80 kc/s is indicated. Experimental results on the magnitude of the electrical input impedance as a function of frequency and Hg column length are given. A comparison of the variable resonant frequency unit used as a transducer with a series of fixed resonant frequency transducers is presented.

A.

534.232 : 621.396.616

4202. Ultrasonic generators for high powers. B. E. NOLTINGK. *J. Brit. Instn Radio Engrs*, **11**, 11–21 (Jan., 1951).

Piezoelectric and magnetostriction generators are described briefly, particular reference being made to methods of mounting, permitting the units to be used in almost any type of liquid. In one type of crystal transducer, araldite resin is used to make a watertight joint between the edges of the crystal plate and its supporting brass ring. Generators for such purposes as flaw detection are noted and the construction of an ultrasonic soldering iron for aluminium is shown in a diagram and its action described.

A. WILKINSON (R)

534.32 : 534.23

4203. Note on the different effects of sound absorption on the sound of new and old violins. H. BRINER. Note in *Experientia*, **7** (No. 2) 59–60 (1951) In German.

The “residue” theory of J. F. Schouten (*Philips techn. Rdsch.*, **5**, 294 (1940)), explains how the absorption of h.f. harmonics changes the tone quality and loudness of old violins less than that of modern ones. Following this theory it appears that the h.f. harmonic components contribute directly to the sensation of the fundamental sound. Consequently in new violins, rich in high partial components, the room absorption has its effect not only in these high partials but also in the fundamental component sensation.

A. B. WOOD

534.321

4204. Some observations on pitch and frequency. H. DAVIS, S. R. SILVERMAN AND D. R. MCAULIFFE. *J. Acoust. Soc. Amer.*, **23**, 40-2 (Jan., 1951).

"Tone-pips" were produced by brief rectangular electrical pulses being delivered through two sound-effects filters in cascade with both high and low cut-offs set at 2 000 c/s. Nearly all of the acoustic energy of the final signal was found to be concentrated in a band about an octave wide and centring at 2 000 c/s. The pulsing frequency was varied independently between 90 and 150 pips/sec. Listeners describe the resulting sound as a "metallic buzz," and vary greatly in their ability to identify the two "itches" present and in the accuracy of matching with a pure tone either the pulsing frequency (about 130 c/s) or the band-pass frequency (2 000 c/s in the present series). Errors of exactly one octave are particularly common. It is argued that the "pitch" of a pure tone is a double attribute compounded of "buzz" (correlated with frequency of volleys of nerve impulses) and "body" (correlated with position of maximum stimulation on the basilar membrane). A.

534.322

4205. A new interpretation of "residue." H. MOL. *PTT-Bedrijf*, **3**, 110-11 (Jan., 1951).

The author interprets "residue" as the "chroma" of a complex sound. A.

534.322.1 : 534.132

4206. The voicing of organ flue pipes. D. M. A. MERCER. *J. Acoust. Soc. Amer.*, **23**, 45-54 (Jan., 1951).

The art of "voicing" an organ pipe, that is, treating it in order to produce a satisfactory musical tone, is highly developed, but on an entirely empirical foundation. Flue pipes only are dealt with here, chiefly the open diapason, an open metal cylindrical pipe. The several tone-producing mechanisms in it are described, and some two dozen different variables, each of which can affect the tone, are described with reference to the stage in manufacture in which they occur. Some account is given of the interrelationship of the various adjustments. Finally mention is made of the place of any one pipe in the tonal structure of a complete organ. A.

534.374 : 612.85

4207. Acoustic filters as ear defenders. J. ZWISLOCKI. *J. Acoust. Soc. Amer.*, **23**, 36-40 (Jan., 1951).

Ear wardens in form of ear plugs acting as acoustic low pass filters are described. They allow a part of speech frequencies to pass through into the ear and in this way improve the speech intelligibility in comparison with other ear plugs. Nevertheless their protective action against noise was proved to be sufficient. A.

534.39 : 548.73

4208. Some effects of vibration on X-ray diffraction by crystals. J. E. WHITE. *J. Acoust. Soc. Amer.*, **23**, 16-18 (Jan., 1951).

A technique is described which makes use of Bragg reflection of X-rays to give a "picture" of the vibration pattern on the face of a crystalline plate. The dependence of this pattern on the direction of the X-ray beam is illustrated, and a comparison between dust

patterns and X-ray patterns for a vibrating bar fairly well establishes that the local curvature of the crystal is responsible for the observed increase in X-ray reflection. Reference is made to quantitative measurements on statically bent quartz and to an approximate theory treating the effect. A.

534.6 : 621.395.6.08

4209. Errata: Acoustic measurements. L. L. BERANEK. Letter in *J. Acoust. Soc. Amer.*, **23**, 115-16 (Jan., 1951). See Abstr. 5644 (1950).

534.61

4210. On the accuracy of the method of best beats for determining the intensity of a tone. J. M. WARREN AND J. P. EGAN. Letter in *J. Acoust. Soc. Amer.*, **23**, 111-13 (Jan., 1951).

The method of "best beats" is useful in measuring the equivalent intensity of an aural harmonic of a combination tone [see Wegel and Lane, *Phys. Rev.*, **23**, 266 (1924)]. In the experiments described, the reliability of this method has been tested as a function of the difference in frequency between the two beating tones. To determine the validity of the method the exploring or secondary tone f_s was made to beat with a primary tone f_p of known intensity. In all experiments f_p had a frequency 400 c/s and intensity 50 db above 0.0002 dyne/cm², the frequency of the tone f_s being varied from trial to trial. Curves of results are given for three different observers and the results discussed in terms of standard deviation in db against frequency of beats in c/s. A. B. WOOD

534.61

4211. On the correspondence between the intensities of two tones for best beats. R. G. KLUMPP AND J. P. EGAN. Letter in *J. Acoust. Soc. Amer.*, **23**, 113-14 (Jan., 1951).

See previous Abstr. In this investigation the relation between the intensity of f_s (the exploring or secondary tone) and the intensity of f_p (the primary tone) when $f_s - f_p = 2.5$ c/s, was determined by the method of best beats. The results (average of 6 observers) show that the relationship between the intensity of the secondary tone and the intensity of the primary tone for best beats is very nearly linear with a slope only slightly less than unity. The range of intensity level used in the experiments varied between 60 and 110 db. A. B. WOOD

534.612

4212. Absolute measurement of sound pressures at high frequency. V. TIMBRELL. *Nature, Lond.*, **167**, 306-7 (Feb. 24, 1951).

Describes an optical system of the Mach-Zehnder type in which 2 widely separated light beams are caused to produce interference fringes. The sound under investigation is propagated in one light track without affecting the other. In the system described minute and rapid fringe shifts can be measured accurately. A particular application under consideration is the investigation of the distortion of a sound wave of finite amplitude in air and the formation of a shock-front. In the experiments described peak excess pressures of the order of 10⁴ dynes/cm² have been used. The apparatus is being further developed for the calibration of microphones, loudspeakers, etc. A. B. WOOD

534.614 : 532.74

4213. Measurement of the propagation velocity of sound in liquids at low temperatures. A. DE BOCK. *Verh. K. Vlaamse Acad. Wetensch., Belg.*, **11** (No. 31) 48 pp. (1949) In Dutch.

An ultrasonic interferometer, using a piezoelectric quartz crystal and a reflector immersed in the cooled liquid (down to -100°C) is described. The velocity decreases with increasing temp. linearly, with CCl_4 and C_6H_6 , and almost linearly with ethyl ether, CS_2 , toluene and liquid O_2 . The method is used to obtain the compressibility coeffs. and degrees of association of the liquids. CCl_4 and C_6H_6 show little association; CS_2 , much more.

J. GRANT

534.64

4214. Measurement of acoustic resistances. Methods of measurement. II. W. WILLMS. *Arch. tech. Messen., Issue No. 179* (Ref. V54-6) T134-5 (Dec., 1950) In German.

See Abstr. 1687 (1951) for Part I. In this part are described: null methods—developed by G. W. Stewart and by K. Schuster (including the Schuster Bridge); methods requiring the measurements of sound pressure and sound flux (v. Beke's method); measurement of reaction on the vibrating mechanical system, (a) vibrometer (E. Meyer and von Radinger, Böhme, Nukiyama and Matsudeira), (b) electric reaction on an electro-mechanical system; interferometers (a) for electromechanical sound transmitters (Kosten and Zwicker) and (b) for capacitative and piezoelectric sound transmitters.

A. B. WOOD

534.835

4215. Combating noise in offices. W. FURRER, A. LAUBER AND P. H. WERNER. *Tech. Mitt. PTT, Bern.*, **29**, 41-8 (Feb. 1, 1951) In French and German.

Methods of reducing noise include the use of sound-absorbent materials on walls and of pads of elastic material between machines (i.e. typewriters, etc.) and table tops. Curves are given, showing the measured improvement obtained in a particular office.

V. G. WELSBY

534.836

4216. Spectra and loudnesses of modern automobile horns. D. B. CALLAWAY. *J. Acoust. Soc. Amer.*, **23**, 55-8 (Jan., 1951).

Over-all sound levels on the axis at 3 ft ranged from 108 to 125 db. Loudness levels ranged from 125 to 140 phons. Fundamental frequencies of all horns ranged between 160 and 380 c/s. Two types had approximately harmonic overtones, with large amplitudes below about 2000 c/s and smoothly decreasing amplitudes at higher frequencies. A third type, with the most unpleasant sound, had inharmonic overtones, groups of which were greater in amplitude than the fundamental. Filtering out overtones above 1200 c/s improved the quality of horn sounds markedly, reducing the loudness level inside the automobile by four phons at 50 ft, but only one phon at 300 ft. Since the typical horn is louder than necessary at close range, use of a low pass acoustic filter on automobile horns appears desirable.

A.

OPTICS . RADIATION . SPECTRA 535

535.14

4217. Note on quantum effects in optics. U. FANO. Letter in *J. Opt. Soc. Amer.*, **41**, 58-9 (Jan., 1951).

Examines the probability that a given number of photons will be passed by an optical device such as a Nicol prism on which a given number of photons, with a given distribution of polarization and with coherent or incoherent superposition, is incident.

P. M. DAVIDSON

535.214.6

4218. Theory of positive and negative photophoresis. P. TAUZIN. *C.R. Acad. Sci., Paris*, **232**, 493-5 (Feb. 5, 1951) In French.

Positive effect is defined as repulsion between two small illuminated particles, due to the side receiving the light being heated by absorption. The negative effect is accounted for if the particle is only slightly absorbent, in which case the convection currents set up produce an attraction.

N. CORCORAN

535.223

4219. Proposed new value for the velocity of light. L. ESSEN. *Nature, Lond.*, **167**, 258-9 (Feb. 17, 1951).

The methods used at the National Physical Laboratory and Stanford University are briefly compared. From a consideration of the values obtained and the precision of measurement of these and other recent determinations it is suggested that a value of 299 790 km/sec be adopted. Attention is drawn to the need for an accurate value of the refractive index of air at radio frequencies. Measurements made at the National Physical Laboratory at a frequency of 24 000 Mc/s indicate that the value for dry air is very near that obtained by extrapolation from the most reliable optical determinations.

L. ESSEN

535.23.08

4220. A very sensitive radiometer. A. MERLAND AND S. LÉVÊQUE. *C.R. Acad. Sci., Paris*, **232**, 610-12 (Feb. 12, 1951) In French.

The sensitivity of a standard Crookes-Nichols radiometer is increased by 50 by charging the vanes electrostatically, thus rendering the equilibrium unstable. A flux of 2.8×10^{-6} lumens is detectable.

N. CORCORAN

535.241.44 : 612.843.615

Brightness relationships for comfortable seeing. See Abstr. 4965

535.244

4221. The accuracy of polarization photometers. W. H. STEEL. *J. Opt. Soc. Amer.*, **41**, 223-8 (April, 1951).

The accuracy of a polarization photometer is limited by the inherent non-uniformity of polarization due to divergence of the light beams, and by defects in the polarizers. The errors arising from these causes are evaluated and are compared for systems using two or three polarizers in each beam. It is shown that an accuracy of 0.001 is feasible for intensity ratios as great as 1 000 to 1.

A.

535.245 : 518.5 : 628.9

4222. A slide rule for lighting calculations. P. MOON AND D. E. SPENCER. *J. Opt. Soc. Amer.*, **41**, 98–103 (Feb., 1951).

With a single setting, the rule gives average lumens per unit area at table level, the coefficient of utilization, and the helios (brightness) ratios for walls, ceiling and floor. The device is applicable only when standardized reflectances are employed in the room. For other values of reflectance, similar slide rules may be constructed or simple approximate formulae of an exponential type may be used. A.

535.247

4223. An improved slit for a projection microphotometer. J. H. ALTMAN. Letter in *J. Opt. Soc. Amer.*, **41**, 56–7 (Jan., 1951).

535.31

4224. Proposal of the International Commission of Optics for international standardization of sign conventions and symbols in geometrical optics. S. S. BALLARD. Note in *Amer. J. Phys.*, **19**, 122 (Feb., 1951).

535.31 : 535.41

4225. Errata: High precision measurements with simple equipment. A. C. S. VAN HEEL. Letter in *J. Opt. Soc. Amer.*, **41**, 278 (April, 1951).

See Abstr. 2500 (1951).

535.315

4226. A new constant-deviation prism arrangement. S. MAKISHIMA, Z. KOANA AND K. OSHIMA. *J. Opt. Soc. Amer.*, **41**, 249–52 (April, 1951).

Describes a new arrangement which is characterized by higher brightness, greater resolving power and increased accuracy of wavelength as compared with types hitherto known. This arrangement consists of two equal half-prisms placed separately with their divided surfaces outward and a rotative plane mirror properly placed in some position between them. It is easily shown that the condition of minimum deviation is satisfied at every angular position of the mirror. When used as a monochromator, therefore, no errors occur in the wavelengths of emergent rays computed for the condition of minimum deviation, even when errors occur in the mounting of the prisms or the mirror. This was proven by tests on a quartz monochromator constructed on this principle. Further, the aperture of the instrument suffers no change by rotation of the mirror. Since the prisms are held fixed with their divided surfaces perpendicular to the axes of the collimator and the telescope, the aperture remains constant at its largest value available, quite independent of the wavelengths used. This results, naturally, in some gain of resolving power. A.

535.317

4227. On the extension of a system for differential correction of lens systems to include second-order terms. N. J. RUMSEY. *J. Opt. Soc. Amer.*, **41**, 229–34 (April, 1951).

The possibility is investigated of extending the design procedure developed by Cruickshank for differential correction of lens systems to include the effects of second derivatives. The most convenient variables for use in the 1st-order work prove unsuitable for the extension to 2nd-order. Choosing new

variables, a general method for using 2nd-order coefficients is developed. This threatens to be laborious in practice, but a simplified procedure suitable for the case of bending is described having advantages over other methods commonly used at present. A.

535.317.5 : 535.12

4228. Wave theory of aberrations. H. H. HOPKINS. *Oxford, Clarendon Press* (1950) 167 pp.

The propagation of waves is made the basis of the theory of the action of a lens system. The aberration of the system then emerges as the departure of the emergent wave-front from sphericity. Subjects covered are: wave-front aberration from a knowledge of the paths of rays through the system; an extended treatment of the Abbe sine condition and of Herschel's condition; expansion of the aberration function of a symmetrical system (with discussion of the terms which are included in, among others, the Seidel aberrations and those implicit in the departure from the sine condition); astigmatism and the other aberrations arising on refraction (or reflection) at a single surface; theory of the first-order aberrations of a centred lens system (the resulting "aberration sums" are in a simple form well suited to manipulation during the process of designing a lens system); a full account of the techniques used in lens computing, and the theoretical bases of these procedures; the general aberrational properties of single lenses and the conditions under which certain arrangements of lenses may be corrected; "total" aberration at a surface (measured with respect to the focus of the ray itself), leading to a general formula which includes the well-known formula of Conrady as the special case of an axial object; theory of the aberrations of conicoids and of reflecting surfaces. H. H. HOPKINS

535.32 : 536.41 : 539.32

4229. Mechanical and thermal properties of certain optical crystalline materials. L. S. COMBES, S. S. BALLARD AND K. A. MCCARTHY. *J. Opt. Soc. Amer.*, **41**, 215–22 (April, 1951).

Properties of interest in infrared instrumentation have been measured. Tables are included which list values of Young's modulus, apparent elastic limit, modulus of rupture, modulus of rigidity, hardness and linear coefficient of thermal expansion. Major data are reported on the following crystals: AgCl, Ti(Br-I), Ti(Br-Cl), NaCl, KCl, KBr, LiF and CaF₂. Some data are also given for a dozen-odd other optical materials. Literature values of elastic coefficients are stated for comparison, as well as the values of Young's modulus and modulus of rigidity calculated from these coefficients. A brief discussion is given of the variation of the elastic moduli with direction in the crystal, for cubic crystals. A.

535.321

4230. Prism reflections aiding index measurements. F. MOONEY. *J. Opt. Soc. Amer.*, **41**, 247–8 (April, 1951).

The important features of two achromatic slit images, which appear near minimum deviation for an isosceles prism, are described and applied for refractive index determinations. Either of these images can be utilized in a prism orientation technique equally

suited for visible and non-visible wavelengths. This technique has been tested by determining the refractive index curves (0.4 to $2\ \mu$) of isosceles prisms prepared from six Eastman Kodak glasses. Another tested technique is presented whereby the angular separation of these two images is used to determine the angles of an equilateral prism with a negligible uncertainty. A.

535.327

4231. Fluctuations in the change of refractive index of glasses as a function of temperature. A. WINTER-KLEIN. *C.R. Acad. Sci., Paris*, **232**, 829–31 (Feb. 26, 1951) *In French*.

Superimposed on the almost smooth curve of n against T between room temperatures and the annealing range are irregular but reproducible fluctuations of amplitude $\sim 2 \times 10^{-4}$ and period $\sim 50^\circ\text{C}$. The period gets shorter with more complex glasses and there is some evidence that each fluctuation is associated with a definite component of the glass.

R. O. DAVIES

535.33.07

4232. Optimum optical density in spectrophotometry. R. COLE. *J. Opt. Soc. Amer.*, **41**, 38–40 (Jan., 1951).

Equations are developed which give values for the optimum optical densities at which to run spectrophotometric analyses. Calculations made on a range-of-error basis show that the optimum optical density is 0.5553 (27.84% transmission); on a probable error basis the optimum optical density is 0.4816 (32.99% transmission). However, the precision of measurement is about the same for optical densities from 0.3 to 0.9 (or transmissions from 50% to 12.5%). The treatment is presumably valid for any type of single-beam spectroscopy in which the receiver (including amplifier) has a limit of precision (dI) which is independent of the size of signal received. Thermopiles and photoelectric cells are in this class. Where the intensity is detected by visual comparison, dI/I is independent of the size of signal, and the treatment is not valid. A.

535.33.07

4233. A recording grating spectrometer with linear wavelength scale. G. P. KOCH, W. J. TAYLOR AND H. L. JOHNSTON. *J. Opt. Soc. Amer.*, **41**, 125–9 (Feb., 1951).

A large Wadsworth grating spectrometer designed primarily for photoelectric recording is described. Important features of the instrument are an arrangement which permits any wavelength interval up to the full range of the spectrometer to be scanned in one continuous operation and a wavelength scale which is linear over the entire spectral range (2000 to $14\,000\ \text{\AA}$). The linear scale results in part from scanning the spectrum on the grating normal, a condition which leads also to minimum aberrations in the spectral image. Provision is made for indicating on the spectrum record reference marks which denote equal increments of wavelength. Multiplier photo-tubes, operating at liquid N temperature, are used in the photoelectric recording system. The scanning slit (or photographic plate) is maintained automatically on the focal curve by a simple focusing device. The spectrometer is fully adaptable to photographic work and may be converted from

photoelectric recording to photographic recording (or vice versa) in about 5 min. A.

535.33.07

4234. Chamber for controlled atmosphere spectral excitation. L. E. OWEN. Letter in *J. Opt. Soc. Amer.*, **41**, 139 (Feb., 1951).

535.33.07

4235. The optical image transformer. W. BENESCH AND J. STRONG. *J. Opt. Soc. Amer.*, **41**, 252–4 (April, 1951).

In principle, the use of longer slits is indicated in spectroscopy wherever the resolution is energy limited. Various problems arise, however, as slits are lengthened beyond the conventional limits. This paper sets forth practical solutions to some of these difficulties through the use of an image transformation method, and discusses the advantages and limitations of the schemes suggested. A.

535.33.07 : 771.534

4236. Criteria for pre-exposure of spectroscopic plates. L. M. BRANSCOMB. *J. Opt. Soc. Amer.*, **41**, 255–60 (April, 1951).

Criteria are found for the optimum pre-exposure to be used to hypersensitize spectroscopic plates for the spectrophotometry of very weak light sources. The concept of the ratio of line strength to granularity (signal-to-noise ratio) in spectrophotometry is developed. Experimental investigations of the relations between emulsion response, granularity and exposure yield a simple procedure for determining the pre-exposure which maximizes the ratio of line strength to granularity. This pre-exposure also maximizes the incremental plate density for weak exposures, so that under certain conditions the optimum pre-exposure is the point on the Hurter–Driffield curve at which the 1st and 2nd derivatives are equal. A.

535.33.07–14 : 621.317.761.029.64

4237. A frequency meter for microwave spectroscopy. J. D. ROGERS, H. L. COX AND P. G. BRAUN-SCHWEIGER. *Rev. Sci. Instrum.*, **21**, 1014–15 (Dec., 1950).

A frequency meter using known absorption lines as microwave frequency standards has been developed. By mixing signals of unknown microwave frequency f_x , standard microwave frequency f_0 , and known signals nf_c from a crystal-controlled harmonic generator, it is possible to obtain a set of “beat” frequencies f_r which can be detected by a calibrated radio receiver. From the relation $f_r = \pm m(f_x - f_0) \pm nf_c$ it is possible to determine values for the unknown microwave frequency f_x . Tests on methanol absorption lines with ammonia lines as microwave frequency standards show that microwave frequencies can be determined to $\pm 0.03\ \text{Mc/s}$. Advantages of this device over other frequency-meters are discussed; the accuracy is ultimately limited by the uncertainties in the value of the standard frequency f_0 . A.

535.33.07–15

4238. The design and performance of a double-beam infrared spectrophotometer. F. M. RUGG, W. L. CALVERT AND J. J. SMITH. *J. Opt. Soc. Amer.*, **41**, 32–8 (Jan., 1951).

A double-beam infrared spectrophotometer is described. The features include use of one solid

angle of radiation for both beams (alternating at 5·5 c/s); interchangeable NaCl and KBr prisms and 3 600 and 7 500 lines per inch gratings; and optional modes of automatic recording, either percent transmission on strip chart or expanded recording of energy differences. Significant is the use of two rotating segmented mirrors with the source being imaged in the plane of the first mirror, then in the plane of the second, and, finally, upon the entrance slit of the spectrometer. Steadiness of the source image upon the slit is, therefore, independent of adjustment and quality of the rotating mirrors. A.

535.33.07-15

4239. Calibration of infrared spectrometers. A. E. MARTIN. Letter in *J. Opt. Soc. Amer.*, **41**, 56 (Jan., 1951).

535.33.07-15

4240. A ten channel infrared spectrograph. J. T. AGNEW, R. G. FRANKLIN AND R. E. BENN. *J. Opt. Soc. Amer.*, **41**, 76-9 (Feb., 1951).

Instrumentation is described with which it is possible to determine the spectral distribution of rapidly varying i.r. sources as a function of time. A 10-channel i.r. spectrometer utilizing a multiple arrangement of Golay pneumatic detectors provides information for a 10-channel electronic switch which presents this information on a single oscilloscope screen. Ag tube "wave guides" are used to conduct radiation passing through 10 separate exit slits to the corresponding detectors. A.

535.33.07-15

4241. Near-infrared spectrophotometry with the Beckman model DU spectrophotometer. W. KAYE. Letter in *J. Opt. Soc. Amer.*, **41**, 277 (April, 1951).

535.338.3

4242. Isotope effect in hydrocarbon flame spectra. G. M. MURPHY AND L. SCHOEN. Letter in *J. Chem. Phys.*, **19**, 380-1 (March, 1951).

535.338.3 : 537.228.5 : 538.615

4243. Studies of forbidden lines and the interionic field in discharge tubes. J. BROCHARD. *Ann. Phys., Paris*, **6**, 108-70 (Jan.-Feb., 1951) *In French*.

The main part of this exhaustive paper deals with forbidden lines in He discharges (observed in discharges excited in special conditions) and with the Zeeman effect of such lines. The interionic field is important in conditions where the forbidden lines are observed, and the effect is studied in detail, with reference to He and H discharges. In the latter case a magnetic field is necessary to enable forbidden lines to appear. The paper describes the exptl. techniques (the spectroscopic apparatus and the discharge tubes, and the optical techniques for measuring spectral line intensities) in detail. The results and their theoretical interpretation are also described at length.

J. D. CRAGGS

535.338.334 : 530.162 : 533.7

4244. Statistical theory of pressure broadening. H. MARGENAU. *Phys. Rev.*, **82**, 156-8 (April 15, 1951).

The statistical theory of pressure broadening is developed for any interaction law in which the potential energy is inversely proportional to some power of

the distance between the molecules, including cases in which the forces change sign. Markoff's method is used. Special attention is given to the broadening produced by dipoles and by quadrupoles. A.

535.338.4

4245. The infrared spectrum of active nitrogen. L. M. BRANSCOMB. *Phys. Rev.*, **82**, 83-6 (April 1, 1951).

Thirty-one bands, including the (0,0) band at 10 440 Å, of the N₂ first positive system have been photographed in the Lewis-Rayleigh afterglow of active N. There is no indication that the $v=0$ level of the B³Π state is preferentially populated as required by the "resonance" theory of atomic re-association using $D(N_2) = 7\cdot383$ V. The analogy between the Lewis-Rayleigh glow and the spectrum of the airglow is discussed briefly. A.

535.342/.343 : 548.7

4246. The influence of temperature and pressure on the electronic term values in crystals. H. K. PAETZOLD. *Z. Phys.*, **129** (No. 2) 123-39 (1951) *In German*.

Experimental investigation on spectral lines of Cr⁺⁺⁺ in Al₂O₃ and BeO·Al₂O₃ and of Nd⁺⁺⁺ in Pr(Nd)(NO₃)₃·6H₂O. Increase of pressure results in a lowering of the centre of gravity of the level system and an increase of term splitting. The temperature increase of line widths may be represented by an exponential function of T , rather than by $T^{\frac{1}{2}}$ as in previous work. This rapid increase is interpreted as being due partly to thermal lattice vibrations.

E. P. WOHLFARTH

535.343-14 : 539.133

4247. The structure and dipole moment of SO₂ from microwave spectra. G. F. CRABLE AND W. V. SMITH. Letter in *J. Chem. Phys.*, **19**, 502 (April, 1951).

Accurate data from low J transitions give S-O 1·4321 Å, $\angle$ O-S-O 119° 2' 1", $\mu = 1\cdot59$ D.

D. H. WHIFFEN

535.343-14 : 539.133

4248. Line breadths of the fine structure of the microwave spectrum of oxygen. R. S. ANDERSON, W. V. SMITH AND W. GORDY. Letter in *Phys. Rev.*, **82**, 264 (April 15, 1951).

The line width parameter $\Delta\nu/c = 0\cdot055$ cm⁻¹/atm. for $K=9$ and varies slightly with K . Interpretation leads to a quadrupole moment for the O₂ molecule of $0\cdot04 \times 10^{-16}$ cm².

D. H. WHIFFEN

535.343-15

4249. The rotation-vibration spectrum of methyl cyanide in the region 1·6 μ-20 μ. P. VENKATESWARLU. *J. Chem. Phys.*, **19**, 293-8 (March, 1951).

A Perkin-Elmer spectrometer with LiF, NaCl and KBr prisms was used. The parallel type bands show, in general, a sharp Q branch and broad but more intense P and R branches. The perpendicular type bands are well resolved and show the expected intensity alternation "strong, weak, weak, strong . . ." of the sub-bands (Q branches). All the fundamentals, except $\nu_8(e)$, which is beyond the region investigated, have been definitely established and vibrational assignments have been made for all the observed bands. Values for the rotational constants from microwave

data have been used to obtain the Coriolis interaction constants, ζ_i , from the observed separations of the sub-bands of the $\perp$ bands. The following values have been obtained: $\zeta_5 = 0.10$, $\zeta_6 = -0.44$, and $\zeta_7 = 0.41$. A.

535.343-15

4250. The infrared spectrum of methyl chloroform in the region $1.6\text{--}20\text{ }\mu$. P. VENKATESWARLU. *J. Chem. Phys.*, **19**, 298-302 (March, 1951).

A Perkin-Elmer spectrometer with LiF, NaCl and KBr prisms was used. Vibrational assignments are given to all the bands observed, and all fundamentals except the torsional vibration have been fairly definitely established. Most of the bands, whether perpendicular or parallel type, show the same kind of *PQR* structure. A.

535.343-15

4251. New measurements on the infrared spectrum of F_2O . E. A. JONES, J. S. KIRBY-SMITH, P. J. H. WOLTZ AND A. H. NIELSEN. *J. Chem. Phys.*, **19**, 337-9 (March, 1951).

The i.r. spectrum of F_2O has been re-examined from $2\text{--}25\text{ }\mu$ with a prism spectrometer and selected regions further examined with a grating spectrometer. Several bands observed by Hettner, Pohlmann and Schumacher have been shown to be caused by impurities. Other bands observed by them have been resolved, and an assignment of fundamental modes has been made which is consistent with dimensions of the molecule obtained from electron diffraction data. Two new bands have been observed and assigned to combinations of the fundamentals. The present observed frequencies and their assignments are: $\nu_1 = 928\text{ cm}^{-1}$, $\nu_2 = 461\text{ cm}^{-1}$, $\nu_3 = 831\text{ cm}^{-1}$, $\nu_1 + \nu_3$ and $2\nu_2 + \nu_3$ at $1\,731\text{ cm}^{-1}$, $3\nu_3 = 2\,460\text{ cm}^{-1}$, $2\nu_1 + \nu_3 = 2\,643\text{ cm}^{-1}$. [Note, *ibid.*, 379, explains independence of this work from that described in Abstr. 7123 (1950)]. A.

535.343-15 : 535.375.5

4252. Remarks on the interpretation of the CH_2 vibrational frequencies of *n*-paraffins. G. M. BARROW. *J. Chem. Phys.*, **19**, 345-6 (March, 1951).

The i.r. and Raman frequencies are calculated for the fundamental vibrations of an infinite *n*-paraffin chain. Valence force constants, chosen to give agreement between the calculated and observed i.r. frequencies, give calculated Raman frequencies which are correlated with observed Raman lines. The difference in frequency to be expected for the Raman and i.r. bands of the CH_2 out-of-plane rocking vibration is discussed. The CH_2 frequencies of propane are calculated from the infinite paraffin chainforce constants and are compared with previous assignments. A.

535.343-15 : 535.375.5

4253. Infrared and Raman spectra of vinylidene cyanide. M. L. DANNIS AND J. J. SHIPMAN. Letter in *J. Chem. Phys.*, **19**, 382 (March, 1951).

535.343.2 : 548.7

4254. Spectrum and structure of crystalline europium salts. I. Europium chloride $\text{EuCl}_3 \cdot 6\text{H}_2\text{O}$. K. H. HELLWEGE AND H. G. KAHLE. *Z. Phys.*, **129** (No. 1) 62-84 (1951) In German.

See Abstr. 6151-2, 7128 (1950). The absorption spectrum was photographed at room temperature and

at $58\text{--}88^\circ\text{K}$ with a 6 m concave grating giving a dispersion of 1 or 2 $\text{\AA}$ per mm. All lines are displaced strongly towards the red on cooling. Analysis of the term splitting showed that the Eu^{+++} ions have the point-symmetry 2 (C_2). (The crystal structure is unknown, supposed monoclinic). A. J. C. WILSON

535.343.2 : 548.7

4255. Spectrum and structure of crystalline europium salts. II. Europium bromate $\text{Eu}(\text{BrO}_3)_3 \cdot 9\text{H}_2\text{O}$. K. H. HELLWEGE AND H. G. KAHLE. *Z. Phys.*, **129** (No. 1) 85-103 (1951) In German.

Contrary to X-ray and goniometric evidence, the crystals are only pseudo-hexagonal. Above 67°K they consist of six monoclinic sectors (point symmetry of Eu^{+++} 2 or *m*), below 67°K of triclinic. The term splitting is analysed in detail. A. J. C. WILSON

535.343.2-14

4256. Erratum: Remarks on the nuclear resonance shift in metallic lithium. W. KOHN AND N. BLOEMBERGEN. Letter in *Phys. Rev.*, **82**, 283 (April 15, 1951). See Abstr. 2524 (1951).

535.343.2-15

4257. The absorption and reflection spectra of the ammonium halides. L. F. H. BOVEY. Letter in *J. Chem. Phys.*, **18**, 1684 (Dec., 1950).

Selective reflection from the solid surface produces inconsistencies in the i.r. spectra of the NH_4 halides. Spectra are measured at temperatures between 20° and -150°C , and frequencies of strong absorption lines and of reflection peaks at -150°C and -120°C respectively are tabulated. Changes in the bands for the chloride and bromide occur near the λ -point temperatures whilst no marked variation for the iodide is found until approximately -120°C . The fluoride gives a constant spectrum throughout. Lower symmetry is indicated for the NH_4 ion in the fluoride. W. R. ANGUS

535.343.2-15 : 535.375.55

4258. The infrared and Raman spectra of trimethylphosphine oxide. L. W. DAASCH AND D. C. SMITH. *J. Chem. Phys.*, **19**, 22-5 (Jan., 1951).

The i.r. absorption spectrum of solid trimethylphosphine oxide has been obtained over the range 450 to $5\,000\text{ cm}^{-1}$. A vibrational assignment is proposed for nearly all the bands observed in the i.r. spectrum as well as for the Raman frequencies observed in aqueous solution. It is shown that the fundamental frequencies of the skeletal vibrations are compatible with reasonable values of the force constants for P-O and P-C bonds. A.

535.343.2-34

4259. Absorption spectrum of crystals at low temperatures. I. The effect of temperature on spectrum of benzene and its monoderivatives. E. KANDA AND I. TSUJIKAWA. *Sci. Rep. Inst. Tôhoku Univ., Ser. A*, **2**, 1-8 (Feb., 1950).

There was a displacement of the bands toward the shorter wavelength and a narrowing of the bands, when the temperature was decreased. The effect of temperature on the benzene band was studied theoretically and results agreed well with experiments; the band shift is proportional to thermal energy and the half-intensity breadth proportional to a root of thermal energy. A.

535.343.2/.3-15

4260. Erratum: The vibrational spectra and structure of inorganic molecules. II. Sulfur S_8 , sulfur chloride S_2Cl_2 , phosphorous P_4 . H. J. BERNSTEIN AND J. POWLING. Letter in *J. Chem. Phys.*, **19**, 139 (Jan., 1951). See Abstr. 8619 (1950).

535.343.3-15

4261. The infra-red spectrum of tropolone. H. P. KOCH. *J. Chem. Soc.* (1951) 512-15 (Feb.).

Tentative empirical assignments of some of the observed vibration frequencies have been made. Considerations based on the characteristic OH absorption lead to a tropolone structural model in which the existence of two equivalent energy minima for the location of a highly mobile tautomeric H is recognized. Infrared spectrometry, may be employed to diagnose the presence or otherwise of the tropolone nucleus in a complex organic structure. A.

535.343.3-15 : 536.7

4262. Substituted methanes: V. Infrared spectra and calculated thermodynamic properties for some trichloromethanes. J. R. MADIGAN AND F. F. CLEVELAND. *J. Chem. Phys.*, **19**, 119-23 (Jan., 1951).

See Abstr. 8644 (1950) for Part IV. Wave numbers and estimated relative intensities for the i.r. absorption bands of CCl_3H , CCl_4 and CCl_3Br and a % transmission curve for CCl_3Br in the region 400-3 500 cm^{-1} are given. Probable values of the i.r. wave numbers are established and compared with previously obtained Raman and calculated values. Assignments of the observed bands are made. Thermodynamic properties—heat content, free energy, entropy and heat capacity—have been calculated from the spectroscopic and molecular structure data to a rigid rotator, harmonic oscillator approximation for 9 temperatures from 298·16° and 1 000°K. A.

535.343.31-15 : 535.375.55

4263. The infrared and Raman spectra of condensed nitric oxide. A. L. SMITH, W. E. KELLER AND H. L. JOHNSTON. *J. Chem. Phys.*, **19**, 189-92 (Feb., 1951).

The i.r. and Raman spectra of liquid and solid nitric oxide have been studied in an attempt to prove the existence of the $(NO)_2$ molecule. The liquid has 4 strong Raman lines at 1 861, 262, 196 and 167 cm^{-1} ; two weaker Raman lines at 1 760 and 487 cm^{-1} ; and 2 strong i.r. bands at 1 863, and 1 770 cm^{-1} . Several weaker i.r. bands can be satisfactorily assigned as combinations by using the observed strong i.r. and Raman frequencies. The spectra were found to be due exclusively to a dimer which probably exists as a bent ONNO molecule. A.

535.343.32-34

4264. Ultra-violet absorption spectra of mercury in solution. M. K. PHIBBS. Letter in *J. Chem. Phys.*, **18**, 1679 (Dec., 1950).

For solutions of Hg in hexane, decane and octadecane the absorption maxima of Hg differ from the values for Hg vapour by definite amounts. When these shifts are plotted against $(n^2 - 1)/(2n^2 + 1)$ (n = refractive index of solvent), straight lines which do not pass through the origin are obtained. The results for Hg in methanol and water lie completely off the straight lines obtained with the alkanes. These observations are in conflict with the results

predicted by Bayliss [Abstr. 5702 (1950)] and suggest that his equation is oversimplified. W., R. ANGUS

535.343.4

4265. The spectrum of iodine excited in the presence of argon. P. VENKATESWARLU. *Phys. Rev.*, **81**, 821-9 (March 1, 1951).

I vapour was excited by an uncondensed transformer discharge in the presence of A. A new band system $\lambda 2785-2750 \text{ \AA}$ is recorded. In addition a large number of new bands are found in the band systems $\lambda 3455-3015 \text{ \AA}$, $\lambda 2730-2520 \text{ \AA}$ and $\lambda 4420-4000 \text{ \AA}$ reported by earlier workers. These band systems are analysed and explained in terms of the fairly well-established term scheme of the I molecule. The absorption data in the region $\lambda 2000-3500 \text{ \AA}$ are discussed in the light of the present results. A.

535.343.4

4266. An investigation of the existence of a sodium lithium molecule. B. B. PHILLIPS, H. M. FROSLIE AND R. H. MCFARLAND. Letter in *Phys. Rev.*, **81**, 898-9 (March 1, 1951).

Although a considerable pressure range was studied, no absorption bands attributable to a NaLi molecule were observed in the region 3 000-8 000 $\text{\AA}$.

R. F. BARROW

535.343.4-14

4267. The microwave spectra of the deuterio-ammonias. M. T. WEISS AND M. W. P. STRANDBERG. Letter in *Phys. Rev.*, **81**, 286 (Jan. 15, 1951).

535.343.4-14

4268. Microwave spectra of deuterio-ammonias. H. LYONS, L. J. RUEGER, R. G. NUCKOLLS AND M. KESSLER. Letter in *Phys. Rev.*, **81**, 630-1 (Feb. 15, 1951).

The absorption of an equilibrium mixture of deuterio-ammonias has been measured from 2 000-17 000 Mc/s and a few of the lines have been assigned to individual molecular species on an intensity basis.

D. H. WHIFFEN

535.343.4-14

4269. Microwave spectrum of phosphine, arsine, and stibine. C. C. LOOMIS AND M. W. P. STRANDBERG. *Phys. Rev.*, **81**, 798-807 (March 1, 1951).

The microwave spectrum of PH_3D , AsH_3D and SbH_3D has been measured. Although a supposedly pure sample of stibine was prepared, phosphine and arsine proved to be major impurities. They were separated from the sample; the microwave spectrometer was used to monitor the distillation process. The quadrupole fine structure associated with the absorption transitions for AsH_3D is used to illustrate the special assumptions which may be made with these molecules having an axis of charge symmetry. These assumptions allow one to rotate the co-ordinate system from the charge-symmetry axes to the inertial axes without thereby adding unknown cross derivatives to the descriptions of the dyadic ∇E_{zz} . Interpretation of the spectrum of SbH_3D is more complicated. It is not found possible to fit the theory to the observed lines without making use of the 2nd-order perturbations caused by a nearby level of different symmetry but of the same J . This perturbation involves the cross derivatives which had previously been assumed to be zero. With the assumption of cross derivatives

approximately 1% of the diagonal terms, the theory fitted experiment within the experimental error. The electric quadrupole interaction in arsine and stibine is thus determined. To measure the electric dipole moment of arsine and stibine, a slight extension is made to the theory of asymmetric tops in a uniform electric field. The ground-state inversion splitting is determined to be less than 0.5 Mc/s for all three molecules. The rotational transitions observed were such that a determination of the structure of these three molecules is made. A.

535.343.4-14

4270. Microwave spectrum and molecular structure of GeF₃Cl. W. E. ANDERSON, J. SHERIDAN AND W. GORDY. *Phys. Rev.*, **81**, 819-21 (March 1, 1951).

Measurements of the microwave rotational lines of 4 different transitions yield B_0 values in Mc/s as follows: 2 168.52 for Ge⁷⁰F₃Cl³⁵, 2 167.53 for Ge⁷²F₃Cl³⁵, 2 166.60 for Ge⁷⁴F₃Cl³⁵, 2 108.13 for Ge⁷⁰F₃Cl³⁷, 2 107.04 for Ge⁷²F₃Cl³⁷ and 2 105.98 for Ge⁷⁴F₃Cl³⁷. For all these forms $D_J \approx 0.6$ kc/s and $D_{JK} < |J|$ kc/s. The molecular dimensions obtained for GeF₃Cl are $\angle \text{FGeF} = 107.7^\circ \pm 1.5^\circ$, $d_{\text{GeF}} = 1.688 \pm 0.017$ Å, and $d_{\text{GeCl}} = 2.067 \pm 0.005$ Å. A.

535.343.4-14

4271. The microwave spectrum and molecular constants of trifluoromethyl acetylene. W. E. ANDERSON, R. TRAMBARULO, J. SHERIDAN AND W. GORDY. *Phys. Rev.*, **82**, 58-60 (April 1, 1951).

Pure rotational transitions, $J = 4 \rightarrow 5$, $6 \rightarrow 7$ and $8 \rightarrow 9$ have been measured for CF₃CCH and $J = 5 \rightarrow 6$ and $8 \rightarrow 9$ for CF₃CCD. These yield for CF₃CCH, $B_0 = 2 877.948$ Mc/s, $D_J = 0.2_4$ kc/s, $D_{JK} = 6.3$ kc/s and for CF₃CCD, $B_0 = 2 696.073$ Mc/s, $D_J = 0.2_6$ kc/s, $D_{JK} = 6.2$ kc/s. If $\angle \text{FCF}$ is tetrahedral, $d(\text{C} \equiv \text{C})$ and $d(\text{CH})$ are assumed to be 1.207 Å and 1.056 Å, respectively, then the bond lengths $d(\text{CF}) = 1.330$ Å and $d(\text{C}-\text{C}) = 1.493$ Å are obtained. Rotational frequencies of molecules in excited bending vibration modes have been measured and found to agree with Nielsen's theory of l -type doubling. A.

535.343.4-15

4272. Analysis of the 774 cm⁻¹ (ν_6) absorption band of F₂CO. A. H. NIELSEN. *J. Chem. Phys.*, **19**, 98-100 (Jan., 1951).

The absorption band at 774 cm⁻¹ in F₂CO, which has the appearance of a parallel-type band for a symmetric top, has been resolved into its rotational fine structure with a grating. An analysis of the band has been performed and reveals the band centre to be 774.40 cm⁻¹ and the average B'' for the two close moments of inertia to be 0.3925 cm⁻¹. The moments of inertia in the upper and lower states are very nearly identical and the coefficient of the $(v^6 + \frac{1}{2})^2$ term in the energy is estimated to be 1.4 cm⁻¹. A.

535.343.4-15

4273. Erratum: The infra-red spectrum of acetylene. E. E. BELL AND H. H. NIELSEN. Letter in *J. Chem. Phys.*, **19**, 136 (Jan., 1951). See Abstr. 962 (1951).

535.343.4-15

4274. The photographic infrared spectrum of CD₃CCH and the structure of methyl acetylene. G. HERZBERG, A. V. JONES AND L. C. LEITCH. Letter in *J. Chem. Phys.*, **19**, 136-7 (Jan., 1951).

535.343.4-15

4275. Infrared absorption spectrum of H₂C = CHD. C. COURTOY, M. DE HEMPTINNE AND M. V. MIGEOTTE. Letter in *J. Chem. Phys.*, **19**, 137 (Jan., 1951).

535.343.4-15

4276. Vibration-rotation spectrum and structure of monochlorosilane. A. MONFELS. Letter in *J. Chem. Phys.*, **19**, 138-9 (Jan., 1951).

535.343.4-15

4277. The hydrogen sulfide band at 1 180 cm⁻¹. H. C. ALLEN, JR. AND P. C. CROSS. Letter in *J. Chem. Phys.*, **19**, 140 (Jan., 1951).

535.343.4-15

4278. Influence of foreign gases at high pressure on the infrared absorption band of methane at 3.3 μ . H. L. WELSH, P. E. PASHLER AND A. F. DUNN. *J. Chem. Phys.*, **19**, 340-4 (March, 1951).

An i.r. absorption cell for compressed gases was constructed and used at pressures up to 600 atmos. In the cell, which was of the reflection type, the length of the absorbing path could be changed from 5×10^{-4} cm to 4 cm by means of metal spacers placed between the window and the mirror. The influence of high pressures of He, A and N on the intensity of the CH₄ band at 3.3 μ was investigated. It was found that the absolute absorption coefficient for the band increases linearly with the density of the foreign gas. With N at 600 atmos. the absorption coefficient is 20% greater than that of the free CH₄ molecule. The magnitudes of the coefficients of induced absorption are compatible with the assumption that the vibrating dipole of the absorbing molecule is increased by the reaction field of the polarizable foreign gas molecules in its neighbourhood. The coefficient of absorption for the free molecule was found by extrapolating the measured coefficients to zero density of the foreign gas. The values derived from measurements with the 3 foreign gases agree closely, and give an average value of 1.075×10^{10} sec⁻¹ cm⁻¹ at NTP. A.

535.343.4-15

4279. Infrared spectrum of stibine. D. C. SMITH. Letter in *J. Chem. Phys.*, **19**, 384-5 (March, 1951).

535.343.4-15

4280. The infrared spectrum of boron trichloride. R. E. SCRUBY, J. R. LACHER AND J. D. PARK. Letter in *J. Chem. Phys.*, **19**, 386-7 (March, 1951).

535.343.4-15

4281. Infrared spectra of CH₂N₂ and CD₂N₂. B. L. CRAWFORD, JR., W. H. FLETCHER AND D. A. RAMSAY. *J. Chem. Phys.*, **19**, 405 (April, 1951).

The i.r. spectra of CH₂N₂ and CD₂N₂ have been investigated in the gas phase between 4 500 and 400 cm⁻¹ using a Perkin-Elmer spectrometer with LiF, NaCl and KBr prisms. The spectra have been correlated with a planar, non-linear configuration for the diazomethane molecule with symmetry C_{2v} . The perpendicular type bands for both molecules are all overlapped or perturbed by neighbouring absorption bands, so that no accurate values for the least moments of inertia have been obtained. Two alternative schemes of assignments for the vibrational frequencies have been proposed and the thermodynamic functions for CH₂N₂ computed. Potential-function calculations have been carried out. A.

535.343.4-15 : 535.375.55

4282. The vibrational spectra of diborane and some of its isotopic derivatives. R. C. LORD AND E. NIELSEN. *J. Chem. Phys.*, **19**, 1-10 (Jan., 1951).

The i.r. spectra of ordinary diborane, of $B_2^{10}H_6$, and of $B_2^{10}D_6$ have been determined in the vapour state over the spectral range $250-3\,800\text{ cm}^{-1}$. The Raman spectra of ordinary diborane and $B_2^{10}D_6$ have been measured in the liquid at -130°C . Qualitative depolarization measurements have been made on nearly all observed Raman lines. The vibrational spectra have been interpreted with the help of the various selection rules and the product rule for isotope shifts. It is concluded that the non-planar bridge model (D_{2h} symmetry) fits the spectroscopic data best, although the unsymmetrical C_{2h} form cannot be definitely excluded. The theoretical and observed vapour heat capacities agree satisfactorily over the temperature range $100-300^\circ\text{K}$. A.

535.343.4-15 : 535.375.56

4283. The infrared and Raman spectra of SiF_4 . E. A. JONES, J. S. KIRBY-SMITH, P. J. H. WOLTZ AND A. H. NIELSEN. *J. Chem. Phys.*, **19**, 242-5 (Feb., 1951).

The i.r. and Raman spectra of SiF_4 have been completely re-examined and extended. The Raman spectrum yields 4 lines at 268 cm^{-1} , 390 cm^{-1} , 800 cm^{-1} and $1\,010\text{ cm}^{-1}$, which have been assigned ν_2 , ν_4 , ν_1 and ν_3 respectively. In the i.r. measurements, both prism and grating spectrometers were utilized. Several bands reported in earlier work have been ascribed to impurities and 9 new bands have been observed and identified. The long-wave ν_4 at 391 cm^{-1} has been observed with a KRS-5 prism and its envelope determined. Bands involving ν_3 appear to have a PR spacing of about 12 cm^{-1} while those involving ν_4 appear to have a PR spacing of about 20 cm^{-1} . A.

535.343.4-34

4284. The absorption spectrum of sulfur hexafluoride in the vacuum ultraviolet region. T.-K. LIU, G. MOE AND A. B. F. DUNCAN. *J. Chem. Phys.*, **19**, 71-2 (Jan., 1951).

The spectrum of SF_6 has been investigated down to wavelengths about $600\text{ \AA}$. The maximum of the first electronic transition is found at about $1\,050\text{ \AA}$. Three other transitions occur between this wavelength and $802\text{ \AA}$, where strong continuous absorption begins, and nothing further can be resolved at shorter wavelengths. Qualitative suggestions are offered about the dissociation of SF_6 and the value of its ionization potential. A.

535.343.4-34

4285. On the ultraviolet absorption of cyanogen chloride. D. P. STEVENSON, D. D. TUNNICLIFF AND C. D. WAGNER. Letter in *J. Chem. Phys.*, **19**, 128 (Jan., 1951).

535.343.4-34

4286. Near-ultraviolet absorption spectrum of benzaldehyde vapor. S. IMANISHI. Letter in *J. Chem. Phys.*, **19**, 389 (March, 1951).

535.347

4287. Near infrared pleochroism. II. The $0.8-2.5\text{ }\mu$ region of some linear polymers. L. GLATT AND J. W. ELLIS. *J. Chem. Phys.*, **19**, 449 (April, 1951).

See Abstr. 5713 (1950) for Part I. Polarized radia-

tion is used to study the pleochroism of aligned specimens of polythene, Nylon, polyvinyl alcohol, polyvinyl chloride and polyvinylidene chloride, in the $0.8-2.5\text{ }\mu$ overtone and combinations region. Assignments of observed absorption bands to various vibration modes of (coupled) $>\text{CH}_2$, N-H and $\text{C}=\text{O}$ groups are attempted. The symmetry of an infinite planar-zigzag $>\text{CH}_2$ chain is discussed as an approximation to that of polythene and, to a lesser extent, Nylon. Some limitations in the interpretation of observed pleochroism and in the application of selection rules are discussed. A pleochroism study, with unpolarized radiation, is made of the molecular alignment in oriented "parowax." A study is made also of the rupture of the intermolecular N-H . . . O bonds in molten and premolten Nylon. A.

535.371

4288. Research with a Geiger point counter on irradiated crystals. J. KRAMER. *Z. Phys.*, **129** (No. 1) 34-44 (1951) In German.

Describes experiments in which various crystals (e.g. corundum and fluorspar) were irradiated with various radiations (X-rays and visible light) and the resulting activities, as a function of time after the irradiation, measured with a point counter. The effect of heat treatment on these time-varying activities is discussed, with data given, in detail. J. D. CRAGGS

535.371

4289. Cathode luminescence of crystalline quartz. D. D. SAKSENA AND L. M. PANT. Letter in *J. Chem. Phys.*, **19**, 134-5 (Jan., 1951).

535.371

4290. Photo-luminescence efficiency of $ZnS\cdot Cu$ phosphors as a function of temperature. R. H. BUBE. Letter in *Phys. Rev.*, **81**, 633-4 (Feb. 15, 1951).

The results offer new evidence for a critical change in the nature of the copper centre when the concentration reaches a certain value. See Abstr. 1752, 2556 (1951). J. EWLES

535.371

4291. The fluorescence of acetone vapor. G. W. LUCKEY AND W. A. NOYES, JR. *J. Chem. Phys.*, **19**, 227-31 (Feb., 1951).

An apparatus has been designed and built for the study of low fluorescence intensities. The "blue" fluorescence of acetone vapour has been investigated from pressures of about 1 mm to pressures of about 200 mm, at temperatures from 25°C to 300°C both with and without the addition of foreign gases, such as O_2 , NO , N_2 and $(\text{CH}_3\text{CO})_2$. It is found at temperatures over about 100°C , and in the presence of O_2 and NO , that there is no structure in the fluorescence of acetone which can be detected, and the wavelength of the intensity maximum is different from that found at 25°C . The shapes of the quenching curves are such as to demand at least two upper electronic states which participate directly or indirectly in the fluorescence phenomenon. The photo-chemical data necessitate a high probability of predissociation of the initially formed state together with a small lifetime probably determined by the rate of predissociation. A.

535.371

4292. Scintillation pulse sizes of solid noncrystalline-type phosphors. M. C. SCHORR AND E. C. FARMER. Letter in *Phys. Rev.*, **81**, 891 (March, 1951).

A continuation of previous work [Abstr. 1750 (1951)].

J. EWLES

535.371

4293. An absolute theory of solid-state luminescence. F. E. WILLIAMS. *J. Chem. Phys.*, **19**, 457 (April, 1951).

The absorption and emission spectra of the Ti-activated KCl phosphor at various temperatures have been computed theoretically. An ionic model is used. The radial charge densities of free Ti^{+} in the ground $^1S_0$ state and in the excited $^3P_1^0$ state are evaluated using the Sommerfeld modification of the Fermi-Thomas method for the core and the Hartree self-consistent field method for the two outer shell electrons. From these wave functions and from the known ionic radius, polarizability, and repulsion energy constant ρ for the ground state, these parameters are evaluated for the Ti^{+} in the excited state interacting with Cl^{-} . The variation of repulsion energy with interatomic distance a is shown to be equal to the variation of S^2/a with a , where S is an overlap integral. The Ti^{+} in the $^1S_0$ and the $^3P_1^0$ states are substituted in dilute concentrations for the K^{+} in KCl, and the change in total energy of the system is calculated as a function of the change in the Ti^{+} nearest Cl^{-} distance Δa with the condition that the remainder of the lattice rearranges to minimize the total energy. The computed spectra at various temperatures are found to be in good agreement with experiment. In addition, new insight is obtained on the detailed mechanism of solid-state luminescence.

A.

535.371 : 537.542

4294. Scintillations in some phosphor-plastic systems. W. S. KOSKI. *Phys. Rev.*, **82**, 230-2 (April 15, 1951).

The scintillation properties of anthracene and stilbene dissolved in polystyrene, Lucite and Paraplex have been investigated. The Lucite and Paraplex solutions were very poor counters, but the polystyrene solutions compared favourably in performance with pure anthracene. A study of the emission spectra indicates that the fluorescence bands of polystyrene overlap the absorption bands of anthracene and stilbene; consequently, it is possible to have an efficient energy transfer from the plastic to the phosphor in these cases and good counting systems result. This is not the case in the systems involving Lucite and Paraplex; consequently, their performance as counters is poor.

A.

535.375.5

4295. The Raman spectrum of allene- d_4 . R. C. LORD AND J. OCAMPO. Letter in *J. Chem. Phys.*, **19**, 260-1 (Feb., 1951).

535.375.5

4296. Influence of substituents on the conjugation of double bonds and on the intensity of Raman spectra. M. HARRAND AND H. MARTIN. *C.R. Acad. Sci., Paris*, **232**, 712-14 (Feb. 19, 1951) In French.

In methyl- and halogen- (Cl and Br) substituted ethyl cinnamates the nature and position of the sub-

stituent influences the intensity and frequency of the $C=C$ bond and the results indicate that the conjugation is weakened by these substituents.

W. R. ANGUS

535.375.5 : 536.48

4297. A low temperature Raman cryostat. W. J. TAYLOR, A. L. SMITH AND H. L. JOHNSTON. *J. Opt. Soc. Amer.*, **41**, 91-3 (Feb., 1951).

A cryostat and Raman tube suitable for observing Raman spectra at low temperatures is described. The cryostat is designed so that the sample may be maintained at any desired temperature between $20^{\circ}K$ and room temperature, using only liquid air or liquid H as refrigerant. Samples which are liquids, solids, or gases at room temperature can be studied. The refrigerant is confined to an all metal system, an extremely desirable feature when liquid H is used for cooling, but, nevertheless, good thermal contact with the sample is achieved. The cryostat is used in conjunction with a Lane-Wells Raman spectrograph and power supply. The intensity of illumination is about half that obtained with the standard Lane-Wells lamp housing at ordinary temperatures.

A.

535.375.54

4298. Raman spectra of NH_4Cl at low temperatures. J.-P. MATHIEU, R. M. AGUIRRE AND L. COUTURE-MATHIEU. *C.R. Acad. Sci., Paris*, **232**, 318-20 (Jan. 22, 1951) In French.

A determination of the frequencies of the Raman lines scattered by a single crystal of NH_4Cl , below the transition temperature of $-30.5^{\circ}C$. The type of vibration concerned with each frequency was settled by measurements of the depolarization. The frequencies found are in general agreement with Krishnan's values [Abstr. 2791 (1947)] and they confirm the profound change in the low frequency spectrum on going below the transition temperature attributed to a change in the lattice by Menzies and Mills [*Proc. Roy. Soc. A*, **148**, 407-22 (Feb. 1, 1935)]. The internal vibrations of the ammonium ion change little; the bands get finer, but retain the same symmetry. The allocation of these to the different vibrations is compared with that made by Wagner and Hornig [Abstr. 5698 (1950)].

A. C. MENZIES

535.375.55

4299. Study of the Raman triplet of ammonia at $3\,300\,cm^{-1}$. A. MARCHAND. *C.R. Acad. Sci., Paris*, **232**, 395-7 (Jan. 29, 1951) In French.

Ammonia, either liquid or dissolved in water, gives rise to a Raman triplet at about $3\,300\,cm^{-1}$, which has been attributed earlier to a vibration-rotation band. Langseth [*Z. Phys.*, **77**, 60-71 (July, 1932)] and Williams and Hollaender [*Phys. Rev.*, **42**, 379-85 (Nov. 1, 1932)] claimed to have resolved it into a series of rotation lines around the fundamental vibration ν_1 . The author used a spectrograph with a dispersion of $5\,Å/mm$, a fine slit, and temperature constant to $0.1^{\circ}C$, but failed to find the fine structure in an 18 N solution. He then applied the tests for a rotation-vibration band of a totally-symmetric vibration due to Placzek and Teller [*Z. Phys.*, **81**, 209-58 (March, 1933)]. It did not behave in the way expected if it had such an origin.

A. C. MENZIES

535.376

4300. Extinguishing action of long wavelength radiation in electrophotoluminescence. I. Experimental results. F. VIGÉAN. *C.R. Acad. Sci., Paris*, **232**, 819–20 (Feb. 26, 1951) *In French*.

535.376 : 532.7

4301. Fluorescence of solutions bombarded with high energy radiation (energy transport in liquids). II. H. KALLMANN AND M. FURST. *Phys. Rev.*, **81**, 853–64 (March 1, 1951).

See Abstr. 224 (1951) for Part I. In organic solutions containing fluorescent molecules a considerable part of the high energy radiation absorbed in the bulk material is transformed into light emitted by the fluorescent molecules. There is a transfer of excitation energy from the bulk material to these molecules which reaches its maximum at concentrations of approximately 1 g/l and higher. Experiments with mixed solvents are described where relatively small concentrations (several mole percent) especially of naphthalene and *o*-diphenylbenzene act in some way as a second solvent. The excitation energy can be localized by investigating the fluorescence of these mixed solvents when different fluorescent solutes are added. It is found that the energy migrates from the original solvent to the second solvent and then to the fluorescent molecule. This intermediate energy transfer can change the light emission curve completely. From this change the dependence of the light emission on internal and self-quenching could be determined. Besides this internal energy transfer, an energy transfer via radiation occurs which is described in detail by studying the absorption of the fluorescent light inside the solution by adding small amounts of a second solute of the order of 0.1 g/l. Such small amounts change the light intensity considerably and shift the spectrum to the spectrum of the second solute. Photographs and data of the spectral distribution of such solutions are presented, which show that such drifts already occur with very small amounts of the second solute.

A.

535.39 : 535.51

4302. Examination of metals under polarized light. II. Applications. B. W. MOTT AND H. R. HAINES. *Research, Lond.*, **4**, 63–73 (Feb., 1951).

See Abstr. 3465 (1951) for Part I. A complete review of applications is given with an extensive bibliography. Recent work on U, Be and Zr is mentioned together with work on reflection from isotropic metals covered with an anisotropic surface film, from faceted isotropic surfaces and from non-metallic inclusions. Some details are given of measurement of the optical constants at normal incidence. A discussion deals with the examination of the structural characteristics of a homogeneous phase, and the identification of inclusions and differentiation between various phases of a complex structure.

H. G. JERRARD

535.39 : 535.51

4303. Examination of metals by polarized light. E. C. W. PERRYMAN AND J. M. LACK. Letter in *Nature, Lond.*, **167**, 479 (March 24, 1951).

535.39 : 535.568.1

4304. The polarimetric determination of the ratio of complex reflection coefficients. R. E. HARTMAN. *J. Opt. Soc. Amer.*, **41**, 244–6 (April, 1951).

The relative merits of the several methods available for the polarimetric determination of the ratio of the complex reflection coefficients of a surface are considered. These considerations are used to define the most satisfactory procedures under various conditions.

A.

535.412

4305. Transmission-like multiple-beam reflexion interference fringes. C. F. BRUCE. Letter in *Nature, Lond.*, **167**, 398–9 (March 10, 1951).

Some results are shown in the use of a modified multiple-beam interference technique in reflection. By obscuring certain reflected rays, transmission-like fringes appear in reflection, i.e. broad sharp lines on a dark background. This arrangement is applied to known methods for measuring thin film thickness by interferometry and to the examination of the oscillations of a vibration unit. Full details of the technique are lacking.

S. TOLANSKY

535.415

4306. Further study on the interference color. H. KUBOTA AND T. ARA. *J. Opt. Soc. Amer.*, **41**, 16–23 (Jan., 1951).

In order to study the interference colours of thin layers on glass surfaces more thoroughly, the authors have extended the study reported in the former paper [Abstr. 5745 (1950)] to the cases of oblique incidence and of multilayers. The colour of a thin layer illuminated by obliquely incident light is shown by curves on an I.C.I. chromaticity diagram. On the basis of these results, the method of coating the layer with a thickness of $\lambda_0/2$ or $\lambda_0/4$ with great precision is discussed. The colours of multilayers for perpendicular incidence are plotted on the I.C.I. diagram. A rule found empirically by Banning concerning the colour of multilayers is proved true so long as the thickness of each layer is nearly $\lambda/4$, or its integral multiples. The I.C.I. illuminant C is used throughout the paper.

A.

535.417

4307. Investigations on the luminosity, contrast and resolution of interfering systems with multiple-beams. The use of complex thin films. C. DUFOUR. *Ann. Phys., Paris*, **6**, 5–107 (Jan.–Feb., 1951) *In French*.

The influence of reflectivity and transmission is studied for the case of a Fabry-Pérot interferometer to be used for the investigation of weak radiations, particularly those close to strong lines. The luminosities of the prism, grating, Lummer plate and Fabry-Pérot interferometers are compared. The most favourable arrangement is a Fabry-Pérot used in conjunction with a photocell. The intensity efficiency of the etalon is improved by using a compound mirror consisting of ZnS-cryolite-ZnS-cryolite-ZnS. A combination of 7 such layers leads to a reflectivity of 90% with an absorption less than 2% for the visible. Such compound layers have lasted a year without alteration. The intensity is 2 or 3 times that of a silvered etalon of equal reflectivity. By

deposition of one double layer on a silvered surface a reflectivity of 98% is obtainable. The experimental technique for the production of the compound layers is described in detail. Fabry-Pérot etalon combinations in series are investigated. A contrast of 10 000 (ratio of maximum to minimum) is obtainable with acceptable intensity. The compound films are discussed with relation to localized fringes for studying surface topography and for interference filters.

S. TOLANSKY

535.417

4308. The effect of phase changes in white light interferometry. L. G. SCHULZ. *J. Opt. Soc. Amer.*, **41**, 261-4 (April, 1951).

The phase change accompanying the reflection of white light from metal films was studied experimentally by interferometric methods. As predicted by electromagnetic theory, the phase change was found to vary with the wavelength of light. Corrections for this variation must be made in white light multiple-beam interferometry if the full sensitivity of the method is to be used in making thickness measurements. Practical suggestions are given for making the required corrections. It is demonstrated experimentally and theoretically that these corrections are practically independent of the film thickness. Precise measurements of phase changes on Ag films gave results closely consistent with those calculated from published values of the optical constants of Ag. No such agreement was found for Al.

A.

535.42

4309. An asymptotic treatment of diffraction problems. II. N. G. VAN KAMPEN. *Physica*, **16**, 817-21 (Dec., 1950).

Simplification of theory of I [Abstr. 6934 (1949)] by use of approximations.

A.

535.42

4310. On the theory of optical images affected by artificial influences in the focal plane. H. BREMMER. *Physica*, **17**, 63-70 (Jan., 1951).

Optical images may be influenced by an artificial modification of the diffraction field in the focal plane in the image space. The effects of this modification are discussed in this paper, starting from an arbitrary distribution of the corresponding attenuation and phase retardation imposed at each point of the focal plane. These distributions may be chosen such as to accentuate special features of the object in its paraxial image. The variety of possibilities in this respect is illustrated by a number of examples. For instance, it appears to be possible to reproduce theoretically the modulus of the gradient of the transparency for absorbing objects, and the modulus of the gradient of the phase-rotation distribution for transparent objects.

A.

535.42

4311. An experiment on the boundary effect. A. MARÉCHAL AND F. NAUDIN. *Rev. Opt. (Théor. Instrum.)* **30**, 65-70 (Feb., 1951) In French.

When applying the Huyghens-Fresnel principle to the calculation of diffraction phenomena, it is assumed that the wave surface is unaffected by the presence of the diaphragm. Sommerfeld has shown that the disturbance due to the diaphragm extends only a few

wavelengths from the boundary. Using a microscope interferometer of the Mach type, fringes near various diaphragms have been photographed showing the extent of this boundary effect and confirming the theory.

R. W. FISH

535.43

4312. On the scattering of plane waves by soft obstacles. I. Spherical obstacles. R. W. HART AND E. W. MONTROLL. *J. Appl. Phys.*, **22**, 376-86 (April, 1951).

An approximate theory is developed for the scattering of plane waves by spherical obstacles with the property $m = \lambda_0/\lambda_1 < 1.5$, where λ_1 and λ_0 are, respectively, the wavelengths of a plane wave in the scattering material and in the surrounding medium. In the exact theory the scattered field is found to be an infinite series of Legendre polynomials whose coefficients are complicated combinations of Bessel functions. By making an approximation in the n th coefficient that is valid when either $|m - 1| \ll 1$ or $2\pi a/\lambda_0 \gg n$ (a = sphere dia.) it is possible to sum the series and obtain analytical closed-form expressions for the total scattering cross-section of the sphere and the intensity of the scattered wave as a function of angle. These approximate expressions are compared in the optical case with the results obtained numerically by the Bureau of Standards Computing Laboratory. As an example of their accuracy and range, it is found that when $m < 1.1$ the relative error in the approximate total scattering cross-section is less than 5% for scatterers of any size; when $1.1 < m < 1.5$, the relative error is less than 5% if $2\pi a(m - 1)/\lambda_0 < 6$ and less than 25% for any size of sphere.

A.

535.43 : 535.32

4313. Effect of small refractive index differences between solution and solvent on light scattering. P. DEBYE AND W. M. CASHIN. Letter in *J. Chem. Phys.*, **19**, 510 (April, 1951).

The only effect is to decrease the accuracy of the experiment. There is no breakdown of the theory.

N. CORCORAN

535.56

4314. Optical rotation of quartz in the infrared to 9.7μ . H. S. GUTOWSKY. *J. Chem. Phys.*, **19**, 438 (April, 1951).

The measurements were made with a Se film transmission polarizer and a similar analyser; a Perkin-Elmer Model 12B infrared spectrometer was used as the monochromator and detector. Anomalous rotatory dispersion was found at wavelengths longer than 3.7μ . A tentative qualitative interpretation of the anomaly is suggested.

A.

535.65

4315. Experimental test of the principles of colorimetry. F. BLOTTIAU. *Rev. Opt. (Théor. Instrum.)* **30**, 6-31 (Jan., 1951) In French.

The C.I.E. system of colorimetry depends on the principle of additivity of the trichromatic components. The Munsell system is independent of this principle and the conditions of viewing used are much more practical than those in the average colorimeter. It is therefore not surprising to find that the results obtained by the two methods are often in disagreement.

The author gives the evidence which has been obtained experimentally, and suggests that a colorimeter should be designed with an extended field of view.

J. W. T. WALSH

535.65 : 621.317.794

4316. Electronic colorimetry. D. W. THOMASSON. *Electronic Engng*, **23**, 91–3 (March, 1951).

The trichromatic method of colour comparison, in which the light intensity is measured at three standard wavelengths, is inadequate for exact colour matching since quite dissimilar spectral distributions could have the same values at the sampling wavelengths. An electronic colorimeter giving the whole spectral curve is described. A lamp throws a beam on to a prism where it is dispersed. A rotating drum with a number of slits selects a narrow band from the spectrum, which is passed on to be reflected from the surface under examination. The reflected light is picked up by a photocell whose output is amplified and displayed as a vertical deflection on a c.r.t. A horizontal sweep is obtained from a rotating mask mounted on the drum shaft and a second p-e cell. Means are provided for correction for the spectral response of the p-e cell. A manually-operated version having ten switched sampling positions and meter indication is also described.

W. G. STRIPP (R)

535.8 : 518.5

4317. Experimental study of a linear filter by an optical method. A. BLANC-LAPIERRE, M. PERROT AND P. DUMONTET. *C.R. Acad. Sci., Paris*, **232**, 788–90 (Feb. 26, 1951) *In French*.

Practical modifications of an optical method of evaluating the distribution of the sum of two independent random variables.

N. L. JOHNSON

535.822.9

4318. Reflecting microscopes with spherical mirrors. K. P. NORRIS, W. E. SEEDS AND M. H. F. WILKINS. *J. Opt. Soc. Amer.*, **41**, 111–19 (Feb., 1951).

Previous designs of reflecting microscope objectives using spherical mirrors have approximated to a design derived from theory due to Schwarzschild, consisting of two concentric mirrors giving a central obstruction of the numerical aperture of 45%. Except for the designs of Matsukov, where the central obstruction takes even higher values, the numerical aperture has been limited to 0.5. Theory has been taken as indicating that there was little room for improvement without a high degree of asphericity in one of the mirrors. By an experimental approach, using a microscope interferometer, it is shown in the present work that the Schwarzschild conditions may be forgotten completely and very useful designs of objectives still produced for purposes where a large field area is not required. Such reflecting systems may be made little bigger than refracting objectives and have numerical aperture 0.60 and 35% central obstruction, and are free from spherical aberration. No refracting components or compensating lenses are employed. Mechanical parts for these objectives and a microscope stand are described.

A.

535.822.9 : 535.41

4319. An interferometer microscope for opaque objects. J. DYSON. Letter in *Nature, Lond.*, **167**, 397 (March 10, 1951).

An optical system is described which, when used

with an ordinary microscope and vertical illuminator, allows the examination of opaque objects by interference at high resolution. Interference is observed between a silvered spot and an image of the object, formed by reflection in a half-silvered surface. A system is described for use with a 4 mm OG of N.A. 1.00, which is capable of indicating steps of 30 Å in height.

R. W. FISH

535.822.9 : 535.41

4320. Contributions to the theory of phase contrast microscopy. L. BERTI. *Nuovo Cim.*, **8**, 26–41 (Jan., 1951) *In Italian*.

An explanation of phase contrast microscopy is given in terms of an interference microscope, the results differing slightly from those of the Zernicke method. The theory is used to determine the most suitable phase shift and absorption of a phase plate for maximum image contrast.

R. W. FISH

535.822.9 : 535.42

4321. The edge effect in phase contrast. L. I. EPSTEIN. *J. Opt. Soc. Amer.*, **41**, 134–8 (Feb., 1951).

If an object under a phase contrast microscope is illuminated with light coming from a point source in such a manner that the image of the source is projected upon one of the edges of the phase annulus, the image of the microscopic object shows certain peculiarities which cannot be accounted for under the hypothesis that the point source is imaged upon the annulus without aberrations. Experiment indicates that in cases where the edge effect is observed, the image of the light source is defocused with respect to the phase annulus. The theory of the edge effect may be adapted from the diffraction theory of the Foucault knife-edge test of Gascoigne and Linfoot. A.

535.822.9 : 778.5

4322. Application of white light flash tubes: cinematography with high speed flashes in ordinary and phase contrast microscopy. M. LAPORTE, O. ROERICH-GOUSSU AND J. DÉJEAN. *C.R. Acad. Sci., Paris*, **232**, 394–5 (Jan. 29, 1951) *In French*.

A high-speed flash tube dissipating about 1 kW and capable of taking 100 frames/sec, when synchronized with a cine-camera, is described. The light intensity is sufficient for phase contrast microscopy, sample frames being shown.

R. W. FISH

535.826

4323. The study of the surface state of tissues by means of replicas. J.-J. TRILLAT AND M. BESSE. *C.R. Acad. Sci., Paris*, **232**, 608–10 (Feb. 12, 1951) *In French*.

A technique is described for the preparation of surface replicas from a gelatine-water solution. The effects of concentration, temperature and time of drying are given. The method is non-destructive, reproduces a great amount of detail, and the replica is easily stripped from the specimen. Photographs of replicas from textiles are shown.

R. W. FISH

535.826.3

4324. On the sharpening of microtome knives for ultra-thin sectioning. J. HILLIER. *Rev. Sci. Instrum.*, **22**, 185–8 (March, 1951).

535.833

4325. Theory and use of the dioptometer. H. S. COLEMAN, M. F. COLEMAN AND D. L. FRIDEG. *J. Opt. Soc. Amer.*, **41**, 94–7 (Feb., 1951).

The dioptometer is a telescopic system which may

be focused on objects appearing to be located at different distances from its entrance pupil. The focusing mechanism of the dioptometer is calibrated in terms of diopters in order that the data obtained using it may be related to the impairment of the performance caused by imperfections in an optical system under test, from the point of view of the human eye. Diptometer D-2 has been used in image quality studies in which measurements were made of astigmatism, curvature of the objective field, curvature of the ocular field, spherical aberration, chromatic aberration, the diopter settings of reticles and parallax. Close agreement was obtained with measurements made with more complex equipment. A.

535.89 : 545.82

4326. On the physics and technology of spectrochemical light sources. H. KAISER. *Trans Instrum. Meas. Conf., Stockholm* (1949) 16–22 (1950) *In German*.

A review of the characteristics and range of usefulness of various types of source. The flame has advantages in its constancy and the small interaction between elements in it. The arc is used for sensitive qualitative analysis. The temp. of the positive column varies greatly with the vapour present, and thus an easily ionized alkali metal may be used as a buffer to control the arc temp. at a low constant value. The high-voltage a.c. arc and the interrupted arc are discussed. The spark is used for accurate quantitative analysis, and is equivalent to a high-frequency, heavy-current arc of short duration in which no equilibrium is reached as in the normal arc. Various types are described, also the effects of electrode shape. The important parameters are total energy in the spark gap, and time of discharge. The glow discharge has applications in the detection of gaseous elements.

S. T. HENDERSON

HEAT 536

536.22 : 532.517

4327. On the thermal conductivity of liquids and polymers and its relation to the pressure coefficient of viscosity. A. BONDI. Letter in *J. Chem. Phys.*, 19, 128–9 (Jan., 1951).

536.33

4328. The calculation of radiative temperature changes. T. G. COWLING. *Centen. Proc. Roy. Met. Soc.* (1950) 19–25.

The assumptions needed in order to derive simple mathematical expressions for radiative flux and radiative heating are briefly discussed. The mathematical expressions are used to draw general conclusions as to the importance of radiative heating in various conditions. The expressions are transformed into forms suitable for numerical or graphical calculations. A method of determining the temperature distribution in radiative equilibrium is outlined. A.

536.41 : 536.48

4329. Thermal expansion at low temperatures. S. VISVANATHAN. Letter in *Phys. Rev.*, 81, 626–7 (Feb. 15, 1951).

Mathematical. An evaluation of the contribution by the conduction electrons. A. J. KENNEDY

536.41 : 537.531

4330. A radiographic method of dilatometry. A. H. SMITH, N. A. RILEY AND A. W. LAWSON. *Rev. Sci. Instrum.*, 22, 138–40 (March, 1951).

A method of dilatometry using X-ray illumination has been developed and applied to measurements of compressibility. Metal samples, 10 in long and $\frac{3}{16}$ in. in dia., are subjected to pressures up to 10 000 atmos. Observations of the length of the compressed sample are made by causing X-rays to cast a shadow on a photographic plate. The changes in length of the shadow are then determined with a comparator. This technique, which has been used to measure the compressibilities of Al, Fe and Cu, is easily adaptable to remote measurements of any type involving changes of length, e.g. thermal expansion. A.

536.413

4331. Determination of small thermal expansion coefficients by a micrometric dilatometer method. B. S. LEMENT, C. S. ROBERTS AND B. L. AVERBACH. *Rev. Sci. Instrum.*, 22, 194–6 (March, 1951).

A method for the measurement of small thermal expansion coefficients in the vicinity of room temperature is described. The thermal expansion of Invar in the room temperature range may be reduced to zero by the elimination of impurities from the basic 36 Ni, bal. Fe composition. A.

536.413

4332. Coefficients of thermal expansion of Au–Cd alloys containing 47.5 atomic percent Cd. L.-C. CHANG. Letter in *J. Appl. Phys.*, 22, 525–6 (April, 1951).

536.42

4333. Critical constants, boiling points, triple point constants, and vapor pressures of the six isotopic hydrogen molecules, based on a simple mass relationship. A. S. FRIEDMAN, D. WHITE AND H. L. JOHNSTON. *J. Chem. Phys.*, 19, 126–7 (Jan., 1951).

536.42

4334. The vapor pressure of mercury from 40°C to 240°C: (5 microns to 6 cm) measured by the streaming method. T. M. DAUPHINEE. *J. Chem. Phys.*, 19, 389–90 (March, 1951).

536.421.1

4335. The effect of pressure on the melting of several methyl siloxanes. P. W. BRIDGMAN. *J. Chem. Phys.*, 19, 203–7 (Feb., 1951).

Previous experiments had left open the possibility that the melting phenomena of the methyl siloxanes might be an exception to the universal behaviour of all other known substances, namely, that there is no experimental evidence for a critical point between solid and liquid or for a maximum or temperature asymptote on the melting curve. The special apparatus necessary for an examination of the siloxanes in this respect has been constructed, and it has been found that they do not constitute any exception. The abnormality of their melting behaviour is sufficiently explained by abnormal subcooling effects connected with the abnormally large increase of viscosity of these substances under pressure. A.

536.421.1 : 536.75

4336. The entropies of melting of metals. R. A. ORIANI. *J. Chem. Phys.*, 19, 93–7 (Jan., 1951).

The melting process can be conceived as consisting of first an expansion, and then a disordering of the

crystalline structure. The entropy contribution from the first effect is calculated by analogy with the process occurring in a volume expansion within an individual phase; the entropy contribution from the melting disorder is then obtained by difference from the measured entropy of fusion. Tentative conclusions of heuristic value are drawn from the relative magnitudes of the various quantities. A simple model for the melting process is adopted, making possible a correlation between the amount of disordering during melting and the structural contribution to the entropy of melting. A.

536.423.15

4337. Vapour pressure measurements of bromine. J. YARWOOD AND D. H. LE CROISSETTE. Letter in *Vacuum*, **1**, 37-8 (Jan., 1951).

536.424 : 541.7 : 548.736.1

4338. On the transition of yellow phosphorus at low temperatures. II. T. SUGAWARA AND E. KANDA. *Sci. Rep. Res. Inst. Tôhoku Univ., Ser. A*, **1**, 153-5 (Oct., 1949).

See Abstr. 8701 (1950) for Part I. Further research on yellow P disclosed that (1) the number of P_4 molecules in a unit cell of the β form is either 58 or 60, (2) the space group is T_d^3 , (3) the transition temperature of the α P lies between -70°C and -83°C , and (4) a new modification was obtained by X-ray irradiation, resembling the so-called Schenk's scarlet P.

F. LACHMAN

536.46 : 518.5

4339. An analog computer for flame gas composition. W. S. MCEWAN AND S. SKOLNIK. *Rev. Sci. Instrum.*, **22**, 125-33 (March, 1951).

Specific impulse is an important parameter used to characterize the ballistic properties of a propellant. The calculation of this quantity has been a very tedious task, because a primary phase of this calculation involves the estimation of the composition of the products of combustion. This operation by standard techniques requires the simultaneous solution of 10 equations containing 10 unknown concentrations of reaction products for propellant systems composed of C, H, O, and N. Iterative procedures have been found most efficient in solving these equations, but these are lengthy even when high speed calculating equipment is employed. An analogue computer has been developed which simulates electrically the conditions of temperature, pressure and composition of combustion products. These conditions are imposed as resistances in a series of interlocking Wheatstone bridges which, when balanced, produce the required resistances proportional to partial pressures. Mole fractions are obtained by dividing the partial pressures by the total pressure which also is produced as a proportional resistance by the computer. A.

536.46 : 536.521

4340. A two-path method for measuring flame temperatures and concentrations in low pressure combustion chambers. S. S. PENNER. *J. Chem. Phys.*, **19**, 272-80 (March, 1951).

The two-path method for flame-temperature determinations has been extended to discrete radiators

observed with instruments of arbitrary resolving power. Representative calculations of radiant intensity have been carried out for l.p. combustion flames in order to ascertain the feasibility of experimental study with standard spectroscopic instruments. It is shown how experimentally determined temperatures and emissivities can be utilized to calculate the concentrations of emitters, provided the emitting species is known and the radiation emitted corresponds to the thermodynamic equilibrium for the local conditions of temperature and pressure. A.

536.48

4341. Measurements on the viscosity of liquid helium by means of the oscillating disc method. A. DE TROYER, A. VAN IITERBEEK AND G. J. VAN DEN BERG. *Physica*, **17**, 50-62 (Jan., 1951).

Measurements by means of the oscillating disk on the viscosity of liquid He were done above, around and below the λ -point, in order to clear up the discrepancy between earlier measurements made in the laboratory. Our measurements required preparative measurements on the constant of the oscillating system, on the value of the penetration depth in the liquid, and the accuracy of the determination of the temperature. The viscosity was approximately constant between 4.2 and 2.6°K , contrary to earlier measurements. Between 2.6 and 1.8°K the value diminishes from 28 to 5 micropoises. The passing of the λ -point does not result in a discontinuity of the viscosity. Between 1.8 and 1.3°K the viscosity decreases from $5 \mu P$ to $1.3 \mu P$, if the density ρ of the liquid as a whole is used in the calculations and not the density ρ_n of the "normal" fluid. A.

536.48

4342. Second shock in liquid helium II? F. REINES. Letter in *Phys. Rev.*, **81**, 282 (Jan. 15, 1951).

536.48

4343. Pressure dependence of second sound velocity in liquid helium II. R. D. MAURER AND M. A. HERLIN. *Phys. Rev.*, **81**, 444-7 (Feb. 1, 1951).

The velocity of second sound as a function of pressure and temperature has been measured to 0.95°K by a pulse method. The quantitative dependence of the rise in velocity upon pressure is found to support the role of the phonons in contributing to the normal fluid flow alone. A.

536.48 : 530.162

4344. A contribution to the theory of Bose-Einstein liquids. C. V. HEER AND J. G. DAUNT. *Phys. Rev.*, **81**, 447-54 (Feb. 1, 1951).

Smoothed potential models for liquid He^4 and liquid He^3 in which each are considered as ideal Bose-Einstein and Fermi-Dirac gases situated in potential wells of potential $-\chi_4^0$ and $-\chi_3^0$, respectively, are considered. It is shown that the degeneracy temperature, T_0 of pure liquid He^4 on this model can be deduced and that the λ -transition temperatures, T_λ , of solutions of such liquids can be calculated. The calculated values of T_λ as a function of concentration of He^3 appear to be in satisfactory agreement with the observed values. From these considerations, predictions are made regarding the behaviour of solutions of two Bose-Einstein liquids; e.g. He^6 in He^4 . It is

shown, moreover, that solutions of such model liquids obey the third law of thermodynamics. Detailed calculations have been made of the vapour pressures of such smoothed potential liquid models of He^4 and He^3 both in the pure state and in solution. The results for the vapour pressures of the solutions indicate that, in the temperature range above 1°K for solutions of not too high concentration of He^3 , the total vapour pressure would be higher than that given by Raoult's law for temperatures both above and below the λ -temperature of the solution. In this way the experimental results for the vapour pressure of such solutions, first emphasized by Taconis, *et al.*, can be explained, and good agreement between theory and experiment is evident. Explicit formulae are given for further numerical evaluation. Finally, the results of calculations of the total vapour pressure of model solutions of He^3 in He^4 in which the He^3 Fermi-Dirac liquid model is extremely degenerate are discussed. It would appear that at very low temperatures ($< 0.5^\circ\text{K}$) the partial vapour pressure of He^3 in such solutions of He^3 in He^4 and the distribution coefficient, C_p/C_L , should become smaller than the values calculable from Raoult's law. A.

536.48 : 541.183

4345. Mobile multilayer adsorption of a Bose-Einstein gas: helium. W. BAND. *J. Chem. Phys.*, **18**, 435 (April, 1951).

The quantum properties of a Bose-Einstein gas give rise to a critical adsorption into a mobile film. If the energy of adsorption is assumed to decrease with thickness according to a simple power law, the theory gives an isotherm in good agreement with observations on He adsorption at temperatures above the lambda-temperature of liquid He, for all gas pressures higher than 10% saturation. With mixtures of He^3 and He^4 isotopes the theory predicts appreciable adsorption of He^3 only in the first or localized monolayer; all mobile monolayers should be practically pure He^4 at all gas pressures. Comparison is suggested with the known isotopic constitution of the Rollin film below the lambda-temperature. A.

536.5

4346. New German technical heat-measuring instruments and controllers. H. TOELLER. *Trans Instrum. Meas. Conf., Stockholm* (1949) 107-13 (1950) *In German*.

Various commercial types are briefly discussed. These include thermocouple photoelectric potentiometers, a rapid response radiation pyrometer, infrared gas analysis apparatus, a thermal conductivity gas tester, pneumatic and potentiometric temperature regulators and a gas-mixture controller. S. WEINTROUB

536.521

4347. Test on the scatter of measurements in optical pyrometry. G. URBAIN. *Rev. Opt. (Théor. Instrum.)* **30**, 32-45 (Jan., 1951) *In French*.

A set of readings of an optical pyrometer are taken as an example and it is shown that the scatter is in accord with the Gauss law and that the standard deviation, s , the mean temperature, t , and a geometrical constant, ρ , are related by $s = 29\rho - 32\rho t - t$. ρ is defined as the ratio of the useful surface of the filament, i.e. the part covered by the image of the

source, to the uncovered surface of the image. Utilizing the results obtained it is further shown by a numerical example how the number of readings, required to be taken to obtain for a given arrangement of source and pyrometer a definite precision in the measured temperature, may be forecast. The paper contains useful graphs of relations between s , ρ and t .

S. WEINTROUB

536.62

4348. Two calorimeters for industrial measurements. A. C. WERNER. *Rev. Sci. Instrum.*, **22**, 245-7 (April, 1951).

Two calorimeters for the determination of the heat capacity of solid materials and heats of fusion are described. Typical data for KNO_3 and for a solution of nicotinic acid in H_2SO_4 are presented. A.

536.63

4349. A dynamic method for measuring the specific heat of metals. A. M. NATHAN. Letter in *J. Appl. Phys.*, **22**, 234-5 (Feb., 1951).

Used for a preliminary study of the specific heat curves of low C steel at the phase transformation points. The cylindrical specimen, 20 cm long and 3 mm dia., is heated electrically by Pb accumulators and a rapid rise in temperature ($1000^\circ\text{C}/\text{sec}$) produced. The voltage drop across the specimen, the heating current, and the temperature, measured by a Pt/Pt 13% Rh thermocouple, are recorded electronically. A block diagram of the set-up is given. Indications of the Curie point at 769°C were obtained.

S. WEINTROUB

536.63

4350. High temperature specific heat of AgBr. R. W. CHRISTIE AND A. W. LAWSON. Letter in *J. Chem. Phys.*, **19**, 517 (April 19, 1951).

The rapid rise in sp. ht. with temp. gives support for the Frenkel mechanism. N. CORCORAN

536.631 : 539.213

4351. Specific heat of amorphous state. T. HASEDA, A. OTSUBO AND E. KANDA. *Sci. Rep. Res. Inst. Tôhoku Univ., Ser. A*, **2**, 16-21 (Feb., 1950).

A general model for supercooled liquid is proposed which involves the "ideal supercooled liquid," crystal nucleus, microcrystallite and crystal. In this model, inhomogeneity which appears in supercooled liquid is attributed to these nuclei and microcrystallites. The authors consider that in the amorphous state, heat energy is absorbed in two ways, one by the kinetic portion and the other by the configurational portion. They derive a formula for the specific heat of an amorphous substance, which shows that (1) supercooled liquid to glassy transition is superficial, depending on the heating rate in the measurement; and (2) if perfect equilibrium is maintained at all temperatures in measuring process, a perfect continuous $C_p \sim T$ curve is obtained. In addition, determination of the true equilibrium value by the use of Nernst's method is proposed. A.

536.633.3

4352. A laboratory experiment on the determination of γ for gases by self-sustained oscillations. W. F. KOEHLER. *Amer. J. Phys.*, **19**, 113-15 (Feb., 1951).

THERMODYNAMICS 536.7/8

536.7

4353. The thermodynamic properties of gaseous titanium. P. W. GILLES AND Q. DE L. WHEATLEY. Letter in *J. Chem. Phys.*, **19**, 129–30 (Jan., 1951).

536.7

4354. The superposition approximation in statistical mechanics of compressed gases. R. W. HART, R. WALLIS AND L. PODE. Letter in *J. Chem. Phys.*, **19**, 139–40 (Jan., 1951).

536.7 : 530.162

4355. The thermo-mechanics of ionized fluids. J. E. VERSCHAFFELT. *Bull. Acad. Roy. Belg. Cl. Sci.*, **36** (No. 10) 688–703 (1950) *In French*.

The author's thermo-mechanical theory of mixed fluids is extended to the case where certain particles are electrically charged. He considers that the equations established give a definite solution of the problem of the thermo-mechanics of transport phenomena.

F. E. HOARE

· 536.7 : 541.135

4356. The thermodynamic properties of binary liquid cadmium solutions. J. F. ELLIOTT AND J. CHIPMAN. *Trans Faraday Soc.*, **47**, 138–48 (Feb., 1951).

An electrode potential study has been made over the interval of 400° to 600°C with Cd as the more electropositive component in the binary solutions, Cd–Pb, Cd–Bi, Cd–Sb and Cd–Sn. The activities and the properties ΔG_i^X , L_i , ΔH , ΔG^X and $T\Delta S^X$ are reported for the 4 binary solutions at 500°C.

A.

536.72 : 536.73 : 537.226 : 538.1

4357. Thermodynamics of a fluid dielectric. W. B. SMITH-WHITE. Letter in *Nature, Lond.*, **167**, 401–2 (March 10, 1951).

Clarification of a comment in a recent paper [Abstr. 5420 (1949)] regarding the application of the 1st law of thermodynamics to dielectric phenomena. The author maintains that discussions of the analogous problem in magnetism by Stoner and Guggenheim are inadequate and erroneous in certain particulars, whereas his own equation is the correctly derived relation in the thermodynamics of fluid dielectrics. The deduction of another relation based on the 2nd law is given. Here it is shown that a certain thermodynamic variable (potential) is constant throughout the fluid. The deduction by Abraham and Becker of the Helmholtz force formula is criticized.

F. E. HOARE

536.75

4358. The well-informed heat engine. R. C. RAYMOND. *Amer. J. Phys.*, **19**, 109–12 (Feb., 1951).

The failure of a heat engine to defeat the second law of thermodynamics by using density fluctuations to convert heat to work without leaving other changes in the universe is usually explained by saying that the fluctuations of the engine itself would defeat such an operation or that the microscopic nature of the fluctuations prevents their being put to a macroscopic

use. It is shown here that with a proper definition of stored information, a heat engine can be made to convert heat to work without other changes in its immediate system, provided that an outside observer creates in the system a negative information entropy equal to the negative entropy change involved in the operation of the engine. This equivalence of a communication entropy change to a thermodynamic entropy change leads to the definition of the entropy of a non-equilibrium system as the algebraic sum of the thermodynamic entropy which the system would have at equilibrium and the information entropy necessary to construct the specified state from the equilibrium state.

A.

ELECTRICITY 537

THEORY . ELECTRONS 537.1

537.12/13

4359. The masses of the negative and positive electrons. J. W. M. DUMOND. Letter in *Phys. Rev.*, **81**, 468–9 (Feb. 1, 1951).

Experimental evidence is shown to lead to a relative difference in the masses m^+ and m^- of positive and negative electrons given by

$$(m^- - m^+)/m^- = 0.82 \times 10^{-4}.$$

P. T. LANDSBERG

ELECTROSTATICS . DIELECTRICS 537.2

537.21 : 538.3 : 621.3.013

4360. Electric and magnetic forces between sphere and wire. W. R. SMYTHE. *J. Appl. Phys.*, **22**, 521–2 (April, 1951).

Formulae are derived for the force and scalar potential of a dielectric sphere in the field of a charged wire and for the force and vector potential of a permeable sphere and a circular cylinder carrying current. When the sphere is conducting the electric force is $q^2 a^2 (\pi \epsilon_v b)^{-1} (b^2 - a^2)^{-\frac{1}{2}} \sin^{-1} (a/b)$ in M.K.S. units, where q is the charge per unit length on the wire, a the sphere radius and b the distance from its centre to the wire. The same formula, with i for q and μ_v^{-1} for ϵ_v , applies to a sphere of large permeability in the magnetic field of a circular cylinder carrying a current i .

A.

537.212 : 538.122

4361. Lines of force in electric and magnetic fields. J. SLEPIAN. *Amer. J. Phys.*, **19**, 87–90 (Feb., 1951).

Assemblages of lines of force are widely used to represent electric and magnetic fields, the density of lines in the neighbourhood of a point being proportional to the intensity of the vector at that point. It is not generally recognized, however, that the properties of continuity and individuality of such lines are irrelevant so far as observable electromagnetic phenomenon are concerned. Contrary to widely held

views, it is not possible generally to represent the magnetic field of a linear circuit carrying a steady current by such an assemblage of lines of force which are everywhere continuous. This is because the continuous magnetic lines of force do not generally form simple closed curves, which each link the circuit just once. The interlinkage which is significant is that between the circuit and arbitrarily chosen closed paths of integration of the magnetic vector. A.

537.213 : 621.317.726

4362. An instantaneous peak voltmeter. M. W. TOBIN, H. GRUNDFEST AND R. L. SCHOENFELD. *Rev. Sci. Instrum.*, **22**, 189–90 (March, 1951).

Analyses the function and limitations of the simple diode condenser-charging peak voltmeter circuit. A new circuit is described for instantaneous measurements of amplitudes of random pulses over a wide range of pulse width and frequency regardless of the amplitude of the previous pulse. The circuit presented is used to measure the peak voltage of square pulses of 0.1 to 20 msec duration at frequencies of 0.2 sec, used for stimulation of nervous tissues. A.

537.221

4363. Interpretation of experiments on frictional electrification. W. R. HARPER. Letter in *Nature*, *Lond.*, **167**, 400–1 (March 10, 1951).

537.226

4364. On the representation of the static polarization of rigid dielectrics by equivalent charge distributions. L. H. FISHER. *Amer. J. Phys.*, **19**, 73–8 (Feb., 1951).

The representation of statically polarized rigid dielectrics (homogeneous isotropic, homogeneous anisotropic, non-homogeneous isotropic) by equivalent induced surface and volume charge distributions is examined in detail. Attempts at interpretation of equivalent surface charge densities in crystals (isotropic and non-isotropic) and of equivalent volume charge densities in crystals (non-isotropic) indicate that, for these cases, the concepts are artificial and are of limited physical significance. Difficulties in interpretation do not arise for gases, liquids, amorphous solids, or solids made up of large numbers of randomly oriented crystals. The corresponding magnetostatic problems are discussed, although interpretation is not attempted in view of the artificiality of the concept of the magnetic pole. A.

537.226.2

4365. Dielectric properties of ketones. V. DANIEL AND K. H. STARK. *Trans Faraday Soc.*, **47**, 149–55 (Feb., 1951).

Experiments by Müller show that in some solid long chain ketones melting is preceded by a rise of the dielectric constant with temperature. Fröhlich deduces theoretically from the structure of the ketones in question that this rise of the dielectric constant may be due to an incipient ferroelectric order-disorder transition. The present paper describes experiments which prove that Müller's results are due to small traces of impurities, and thus cannot be taken to confirm Fröhlich's theory. Reasons are advanced to explain these results. A.

537.226.2

4366. The dielectric constant of water and the saturation effect. F. BOOTH. *J. Chem. Phys.*, **19**, 391 (April, 1951).

The Onsager and Kirkwood theories of polar dielectrics are extended to give expressions for the dielectric constant at high field strength. The theory is applied in detail to water and simple formulae for the dielectric constant in terms of well-known quantities are obtained. From these formulae it is shown that the reduction of the dielectric constant due to the saturation effect is of importance for fields greater than 10^6 V per cm. A.

537.226.2

4367. Temporary enhancement of hysteresis in barium titanate samples. D. R. YOUNG. Letter in *J. Appl. Phys.*, **22**, 523–4 (April, 1951).

537.226.2 : 539.232 : 621.3.011.4 : 621.3.017.143

4368. Capacitance and dielectric losses of an oxide layer deposited on aluminium by anodic oxidation. W. C. VAN GEEL AND J. W. A. SCHOLTE. *Philips Res. Rep.*, **6**, 54–74 (Feb., 1951) *In French*.

A model of the structure of the oxide layer on Al is given, based on measurements of the capacitance and dielectric losses of this layer. It is found that the losses decrease with increasing thickness of the oxide layer. The capacitance as a function of the forming voltage is measured by means of an a.c. bridge and also by the ballistic method. The equivalent circuit for the capacitance of the oxide layer is found to be a series connection of condensers with resistances in parallel. The values of these resistances increase steadily from low to very high values. The layer is considered to be built up in the following way: At the boundary aluminium-aluminium oxide there exists a layer containing an excess of Al atoms. These atoms produce a good conductivity of electronic character. In the direction of the electrolyte the concentration of the excess of atoms decreases. First comes an intermediate layer with higher resistances, and next a layer of very poor conductivity. An applied electric field seems to displace the atoms in excess and to change the mutual ratio of thicknesses of the different layers. The well-conducting layer is the cause of the dielectric losses. A.

537.226.2 : 621.396.621.54 : 621.317.335

4369. The double super-heterodyne principle applied to dielectric measurements. E. B. BAKER. *Rev. Sci. Instrum.*, **22**, 34–6 (Jan., 1951).

By use of two mixers and a common variable local oscillator, a superheterodyne receiver can be converted to serve simultaneously as generator and detector. Such an arrangement provides: (1) single dial tuning, (2) absolute freedom from relative frequency drift, (3) the possibility of very narrow band tuning and, thus, improved signal-to-noise ratio. Circuits to accomplish this are described for the range 0–16 kc/s which occupy no more space than a conventional oscillator, which they replace. Extension of the frequency range to 0–600 kc/s is possible, although in this case single dial tuning is not possible. These circuits are particularly useful for automatic balancing dielectric bridges, but should also be very

useful in work with vibration and sound, and for filter and amplifier frequency response. A.

537.226.2/.3

4370. The dielectric constant and loss-angle of glass. F. NAUDIN. *C.R. Acad. Sci., Paris*, **232**, 831-2 (Feb. 26, 1951) *In French*.

Annealing leads to a decrease in both quantities.

R. O. DAVIES

537.226.3 : 621.365.55

4371. Theory and experiments of frequency-selective heating in heterogeneous dielectrics. Y. OZAWA. *Monogr. Ser., Res. Inst. Appl. Elect., No. 1*, 33-54 (1950).

A new theory is developed for calculating the optimum frequency of selective heating. This theory is derived from Maxwell's fundamental equations. Formulae are developed for the power densities for the conditions of: constant total voltage applied to the source; constant total power supplied; constant total current supplied. The power losses are calculated for systems of two or more layers of non-dispersive dielectrics. The final formula for the frequency of maximum energy absorption is shown to be a function of the geometrical capacitances and conductances of the layers. If the material is composed of both conducting and insulating layers the frequency of max. heating is a function of the dielectric constants, the conductivity, and the shape of the particle. H.f. energy was applied to a system of transformer oil into which a glass bulb containing water was immersed and the temperature measured. Plotting the ratio of the temperature rise in water and oil against the frequency, a peak was found representing the frequency for a max. heating effect. For this particular system, $f_{max} \approx 10^7$ c/s. A formula for f_{max} is given, as is the value of f_{max} for the h.f. glue-setting of plywood. For the temperature distribution in differential heating it is shown that the temperature difference between a particle and its surrounding material is proportional to the size of the particle and the field strength.

W. SUMMER

537.228.4

4372. Transmission line Kerr cell. J. W. BEAMS AND H. S. MORTON, JR. Letter in *J. Appl. Phys.*, **22**, 523 (April, 1951).

ELECTRIC CONDUCTION . CURRENTS 537.3

537.3 : 621.317.723

4373. Circuits and tubes for ultra-sensitive electrometers. F. E. O'MEARA. *Rev. Sci. Instrum.*, **22**, 106-8 (Feb., 1951).

The design of an improved electrometer circuit, which will compensate for voltage fluctuations and random emission changes, is described. The selection of suitable electrometer tubes is discussed. A.

537.311

4374. Anomalous electrical resistance changes in certain alloys. H. THOMAS. *Z. Phys.*, **129** (No. 2) 219-32 (1951) *In German*.

In certain alloy systems containing at least one transition metal and forming primary solid solutions

(e.g. Ni-Cr, Fe-Al, Ni-Al, Fe-Si, Ni-Cu, Ni-Cu-Zn) an anomalous increase of resistance with decreasing temperature is observed at medium and low temperatures. It is found that the resistance of an alloy specimen quenched from a high temperature is increased in this way by annealing in H_2 at temperatures above 200°C but decreased by cold-working. Only a partial explanation of the phenomenon is given.

E. P. WOHLFARTH

537.311

4375. Spectroscopic evidence for the proton conductivity through solid alcohols. Y. KAKIUCHI, H. KOMATSU AND S. KYOYA. Letter in *J. Chem. Phys.*, **19**, 132-3 (Jan., 1951).

The anomalous conductivity through cetyl alcohol is due to high mobility of protons forming H bonds.

J. JACOBS

537.311.31 : 536.48

4376. Low temperature resistance minimum in magnesium measured by a mutual inductance method. H. E. RORSCHACH AND M. A. HERLIN. Letter in *Phys. Rev.*, **81**, 467 (Feb. 1, 1951).

537.311.31 : 536.531

4377. Electrical resistance of platinum at high temperatures. H. E. BENNETT. Note in *Rev. Sci. Instrum.*, **21**, 1029 (Dec., 1950).

537.311.33

4378. Electron bombardment induced conductivity in germanium point contact rectifiers. A. R. MOORE AND F. HERMAN. Letter in *Phys. Rev.*, **81**, 472-3 (Feb. 1, 1951).

Using a scanning technique with electron beams of several keV impinging normally upon a Ge surface with a phosphor-bronze contact inclined at 45° to the crystal, changes in forward and reverse currents resulting from the bombardment may be displayed on an oscilloscope. The interpretation of results involves the idea of generation of holes by the bombardment; these move until they reach grain boundaries. Grain boundaries and subsurface defects may be located by the technique.

C. A. HOGARTH

537.311.33

4379. Measurement of hole diffusion in *n*-type germanium. F. S. GOUCHER. Letter in *Phys. Rev.*, **81**, 475 (Feb. 1, 1951).

537.311.33

4380. Theory and experiment for a germanium *p-n* junction. F. S. GOUCHER, G. L. PEARSON, M. SPARKS, G. K. TEAL AND W. SHOCKLEY. Letter in *Phys. Rev.*, **81**, 637-8 (Feb. 15, 1951).

The voltage-current characteristics for rectifying *p-n* junctions made with high-back-voltage Ge with gallium introduced into one region, are found to agree accurately with Wagner's equation

$$I = I_s [\exp(eV/kT) - 1]$$

Photo-effects are investigated and lifetimes of injected charge carriers determined.

C. A. HOGARTH

537.311.33

4381. The mobility and life of injected holes and electrons in germanium. J. R. HAYNES AND W. SHOCKLEY. *Phys. Rev.*, **81**, 835-43 (March 1, 1951).

The mobilities of holes injected into *n*-type Ge and of electrons injected into *p*-type Ge have been determined

by measuring transit times between emitter and collector in single crystal rods. Strong electric fields in addition to those due to injected current were employed so that spreading effects due to diffusion were reduced. The mobilities at 300°K are 1 700 cm²/volt-sec for holes and 3 600 cm²/volt-sec for electrons with an error of probably <5%. The value for electrons is about 20% higher than the best estimates obtained from the conventional interpretation of the Hall effect and the difference may be due to curved energy band surfaces in the Brillouin zone. Studies of rates of decay indicate that recombination of holes and electrons takes place largely on the surface of small samples with constants varying from 10² to >10⁴ cm/sec for special treatments. A.

537.311.33

4382. Significance of composition of contact point in rectifying junctions on germanium. W. G. PFANN. Letter in *Phys. Rev.*, **81**, 882 (March 1, 1951).

The influence on the formation of rectifying barriers by the passage of donor atoms from the whisker contact into the Ge is discussed. Experiments with collector contacts containing varying proportions of Sb indicate that the barrier conditions at the contact can vary considerably during the forming process and that α , the current gain, is very much affected by this process.

C. A. HOGARTH

537.311.33

4383. On the aggregation of trapping centres in semiconductors or insulators. T. HIBI AND T. MATSUMURA. Letter in *Phys. Rev.*, **81**, 884-5 (March 1, 1951).

The variation of electronic binding energy with aggregation of trapping centres is calculated using a hydrogen-like model for the trapping centre and a Heitler-London model for the calculation of the aggregation process of two or more centres. The results are applied to the cases of colour centres in KCl and the change of work function of BaO with activation.

C. A. HOGARTH

537.311.33

4384. On the semiconductor bornite. C. W. HORTON. Letter in *J. Appl. Phys.*, **22**, 364 (March, 1951).

Voltage-current characteristics for contacts between bornite (a mineral containing copper, iron and sulphur), and copper whiskers, described by Sherbini and Yousef [Abstr. 635 (1941)] are analysed in terms of diode theory, and an energy band diagram for the system is proposed.

C. A. HOGARTH

537.311.33 : 548.5

4385. Growth of germanium single crystals containing p-n junctions. G. K. TEAL, M. SPARKS AND E. BUEHLER. Letter in *Phys. Rev.*, **81**, 637 (Feb. 15, 1951).

Factors controlling the growth of single crystals of Ge in which particular regions have controllable semiconducting properties are discussed. Lifetimes of injected charge carriers in these crystals may be as high as 600 μ sec.

C. A. HOGARTH

537.312.5

4386. Investigations into the external photoeffect in CuO and Cu₂O. L. MEYER-SCHÜTZMEISTER. *Z. Phys.*, **129** (No. 2) 148-60 (1951) In German.

The experiments were carried out by means of a

spherical photocell and, in general, as described by Lenard's method. A spark gap with Zn, Au or Cd electrodes and a double monochromator supplied the incident monochromatic u.v. radiation. The irradiated cathode area measured 0.5 × 2 mm². A quadrant electrometer was used to measure electron currents down to 51 × 10⁻¹⁵ A. O₂ pressures < 0.3 torr produced Cu₂O surfaces, whereas pressures > 0.3 torr yielded CuO cathodes. The geomagnetic field was of no influence on the electrical characteristics of the cathode. The CuO layers have a considerably smaller retardation (deceleration) voltage than the metals. The difference is about 0.55 ± 0.05 V and is independent of the method of cooling employed in the production of the cathode. The energy distribution of the high velocity photoelectrons seems to correspond to that of the metals. The work function increases if cooling takes place in an O₂ atmosphere (O₂ molecules are adsorbed on the surface). Heating reduces the work function (release of O₂ molecules). Adsorbed H atoms will reduce the work function. The base metal (matrix) of the CuO layer does not influence its characteristics. The Cu₂O layers show a much smaller retardation voltage shift than the CuO layers, namely 0.04 to 0.08 V. On heating to 200 to 300°C these values increase to 0.12 to 0.19 V. The work function of Cu₂O > CuO. Cu₂O is a defect conductor while CuO is a semiconductor. It has a negative Hall constant. The Cu₂O current-voltage curve shows a long tail not present in the CuO current-voltage curve.

W. SUMMER

537.312.5

4387. The electrical properties of selenium coatings. P. H. KECK. *J. Opt. Soc. Amer.*, **41**, 53-5 (Jan., 1951).

The dark conductivity and photo-conductivity of thin vacuum-coated Se layers were measured. The results indicate that with coating temperatures below 50°C only vitreous Se is formed, whereas at higher temperatures the formation of monoclinic Se is favoured. Also, the inception of crystalline structure was found microscopically at about 50°C. From the rectifier properties of the layers, it can be deduced that the conduction in the vitreous Se is chiefly of the p-type, whereas the monoclinic allotropic form displays n-type conduction.

A.

537.312.5

4388. On the photo-conductivity of thallosulfide cells. A. W. EWALD. *Phys. Rev.*, **81**, 607-11 (Feb. 15, 1951).

An investigation of the rise and decay of the photocurrent in Tl₂S cells shows that the simple bimolecular recombination theory on which previous quantitative discussions of the photo-effect in Tl₂S were based is inadequate for the complete explanation of these curves. The dependence of the initial slopes of the response curves on light intensity is that to be expected for a homogeneous photo-conductor, but the temperature-dependence of these slopes suggests the presence of barriers which influence the conductivity through the mobility. The variation of both the initial slopes and the steady-state photo-conductivity with temperature indicate an exponential dependence of the mobility upon temperature with an activation

energy of 0.19 eV. These results indicate that Tl_2S conforms to neither the strictly homogeneous model nor the sharp barrier picture but possesses features of both of these models; the photo-effect corresponds to the homogeneous model, but the charge carriers move with a mobility determined by light-insensitive barriers.

A.

537.312.5

4389. New aspects of the photoelectric emission from Na and K. J. DICKEY. *Phys. Rev.*, **81**, 612-16 (Feb. 15, 1951).

The external photoelectric effect for Na and K in the form of thick evaporated layers was investigated with photon energies $h\nu$ up to 6.71 eV. When $h\nu$ was within 1.5 eV of the threshold, the energy distributions of the emitted electrons were like those derived by DuBridge for a simple photoelectric effect involving an ideal metal. For larger $h\nu$, there was a growing preponderance of low velocity electrons. Their appearance could not be correlated, on the basis of a simple emission process, with the assumed parabolic shapes and approximately known widths of the valence bands. The following complications were therefore considered: (a) scattering by other electrons, causing the excited electron to lose energy before escape; (b) absorption of the recoil momentum by a second electron rather than by the entire crystal, resulting in the transfer of only a portion of the photon energy to the photo-electron; (c) modifications of the simple Fermi band by electron interactions, giving the effect of initial energy states much farther below the surface barrier than had been assumed. The spectral distributions showed no evidence of a sharply defined "volume effect" such as might be due to optical transitions between zones. The form of these spectral curves was notably sensitive to variations in the structure of the evaporated films. Either matte or specular Na surfaces could be produced merely by controlling the deposition rate. There was no appreciable difference in the energy distributions for electrons from the two types of surfaces.

A.

537.312.5 : 535.215.1

4390. The enhanced photoelectric emission effect in barium oxide. B. D. McNARY. Letter in *Phys. Rev.*, **81**, 631-2 (Feb. 15, 1951).

Describes enhancement of p.e. effect from thick, well-activated thermionic emitters. A pronounced wavelength-dependence is reported. It is proposed to account for the phenomenon by a few incompletely filled donor levels ~ 1 eV below the conduction band and a few levels just above the filled band.

A. H. W. BECK

537.312.5 : 539.21

4391. Exciton-enhanced photoelectric emission from F-centers in RbI near 85°K. L. APKER AND E. TAFT. *Phys. Rev.*, **81**, 698-701 (March 1, 1951).

The photoelectric emission from F-centres in RbI was measured at 300°K. It was compared with the optical absorption of pure RbI as determined by Fiesefeldt's method at the same temperature. The results were analogous to those previously reported for KI [Abstr. 318 (1951)] and indicated that exciton-enhanced photoelectric emission reached a peak at

$h\nu \sim 5.6$ eV, where the optical absorption had its first maximum. When the films were cooled to 85°K, the exciton-induced emission showed a double maximum separated by a sharp minimum at $h\nu = 5.72$ eV. This minimum coincided with the shifted position of the first optical absorption peak at the lower temperature. The spectral distribution of the yield had somewhat the appearance of a self-reversed spectral line. An attractive explanation is that the photoelectric emission at first increases with the optical absorption, reaches a maximum for an absorption constant near 10^6 cm $^{-1}$, and then decreases as the absorption constant becomes still larger. The decrease is attributed to a sparsity of F-centres near the surface, and to a growing destruction of excitons at the surface as the layer in which they are formed becomes thinner. Yields near the photoelectric threshold were compared qualitatively with Herring's theory of photoemission from impurities in a polar crystal. An upper limit of 1.9 eV was placed on the electron affinity of these RbI films.

A.

537.312.5 : 539.21

4392. Mechanism of exciton-enhanced photoelectric emission in alkali halides. M. H. HEBB. *Phys. Rev.*, **81**, 702-5 (March 1, 1951).

A theoretical interpretation is made of the photoelectric yield from RbI as observed by Apker and Taft. The mechanism used is the following: (1) In the neighbourhood of the first peak in the optical absorption, excitons produced in the crystal diffuse to F-centres and eject electrons from them. (2) The electrons diffuse to the surface and appear as external photo-electrons. Competing with (1) are other processes of destruction of excitons. It is found necessary to suppose that these are localized near the surface to form a dead layer either because of preferential destruction there or a sparsity of F-centres needed for (1). In (2) electrons gradually lose energy to the lattice so that probability of escape through the surface decreases with increasing depth of origin. Combination of these two effects gives photoelectric yield first rising, then falling, with increasing absorption coefficient in agreement with observation. Energy distribution of emitted electrons is calculated and compared with experiment.

A.

537.312.5 : 621.383 : 621.316.5.064

4393. Use of a photo-tube to correlate contact separation with electrical transients. O. E. BERG AND H. E. STAUSS. *Rev. Sci. Instrum.*, **22**, 153-5 (March, 1951).

A method is described which permits correlation between the separation of electrical contact points and the transient voltages occurring across the electrical contacts when a current is interrupted. The current from a photo-tube, energized by light passing through an aperture-slit system mounted on the same relay as the contact points, exhibits on a single-triggered oscilloscope sweep the extent of contact separation on a time axis. This trace is superimposed on the same film frame as a subsequent transient voltage trace when the current is interrupted. The double exposure gives an accurate correlation between aperture and transient characteristic, inasmuch as

the same sweep speed and sweep trigger are used for both traces. The sweep origin is extremely stable. A.

537.312.5 : 621.385.15

4394. Magnetic electron multipliers for detection of positive ions. L. G. SMITH. *Rev. Sci. Instrum.*, **22**, 166-70 (March, 1951).

Two designs of 15-stage electron multiplier in which focusing from one Be-Cu dynode to the next occurs in crossed electric and magnetic fields have been developed particularly for detection of weak beams or pulses of positive ions in magnetic fields. One, with dynodes $\frac{3}{8}$ in wide, is usable in fields between about 250 and 460 Oe while the other, with dynodes $\frac{1}{8}$ in wide, is usable in fields between about 300 and 1100 Oe. It appears likely that, by using still narrower dynodes, such multipliers can be constructed to operate in fields of several thousand Oe. Advantages of these designs over previously described multipliers employing crossed fields are the use of about half the number of insulated plates and less tendency, because of uniformity of the electric field, for breakdown and noise, due to ion feedback, to occur. The uniformity of the electric field also allows quite reliable calculation of the spread in transit time. From this it is concluded that, with a modified collecting system, a multiplier could be built with a rise time between 10^{-11} and 10^{-10} sec, which is very probably less than could be obtained with a static multiplier. A.

537.312.52

4395. On the condition determining the transition temperature of a superconductor. K. F. NIESSEN. *Physica*, **17**, 33-42 (Jan., 1951).

The analogy between superconductivity and ferromagnetism suggests an analogous dependence upon temperature for the part ω of the Fermi sphere covered by Heisenberg's superconducting layer and the relative magnetization I/I_0 in ferromagnetic material below the Curie temperature, I_0 being the maximum magnetization (at $T=0$). This leads to an assumption of what happens at the transition temperature. A.

537.312.62

4396. Relation between lattice vibration and London theories of superconductivity. J. BARDEEN. *Phys. Rev.*, **81**, 829-34 (March 1, 1951).

A gas of non-interacting electrons of small effective mass, m_{eff} , has a large diamagnetic susceptibility. It is shown that the London phenomenological equations of superconductivity follow as a limiting case when m_{eff} is so small that the Landau-Peierls' theory yields a susceptibility $< -1/4\pi$. Justification is given for the use of an effective mass, $m_s \sim 10^{-4} m$, for superconducting electrons in the lattice-vibration theory of superconductivity. This value is sufficiently small to show that the theory gives the London equations and, as a consequence, the typical superconducting properties. The concentration of superconducting electrons, n_s , is smaller than the total electron concentration, n , by about the same ratio as the effective masses, so that $m_s/n_s \sim m/n$, and thus the penetration depth is of the same order as that given by the usual London expression. A.

537.312.62 : 530.145.6

4397. On the quantum theory of superconductivity. R. SCHACHENMEIER. *Z. Phys.*, **129** (No. 1) 1-26 (1951) *In German*.

It is shown that only wave-packets belonging to the degenerate part of the spectrum can be used to explain superconductivity. For elements of the second group of the periodic table these wave-packets are those near the Fermi surface. The Coulomb exchange effect gives an ordered state of the electrons of lower energy than the unordered. According to the theory at least two valency electrons are necessary for superconductivity, so that the alkali metals are not superconductors, although they are on Heisenberg's theory. R. B. DINGLE

537.324 : 533.5

4398. The thermopile for an infra-red spectrometer and its application to a vacuum gauge. T. SAKURAI, K. KANAYA AND K. SHISHIDO. *Sci. Rep. Res. Inst. Tohoku Univ., Ser. A*, **1**, 313-17 (Oct., 1949).

The construction of Bi-Te and Bi-Sb vacuum thermopiles is described and illustrated. They are mounted on mica and the metals are deposited *in vacuo* by evaporation on thin collodion films. The glass envelopes have rock-salt windows. The resistance of the Bi-Te thermopiles was 1-10 k Ω and of the Bi-Sb 0.1-1 k Ω . Measurements of other characteristics of the thermopiles are described, including the effect due to blackening. The thermoelectric powers of the Bi-Te and Bi-Sb junctions were found to be 450 and 120 $\mu\text{V}/^\circ\text{C}$ respectively. Irradiation with chopped i.r. radiation of various frequencies produced an oscillating response and the average time constant of the 20 thermopiles measured was 0.03 sec at atmospheric pressure. Evacuation increased the saturated thermoelectric power and the time constant by about 20 times. A vacuum gauge using a Bi-Sb couple is briefly described.

S. WEINTROUB

ELECTRIC DISCHARGES 537.52

537.523 : 538.67

4399. Plasma oscillations in a static magnetic field. E. P. GROSS. *Phys. Rev.*, **82**, 232-42 (April 15, 1951).

A theory of the small-amplitude oscillations of an ionized gas in a static magnetic field is developed, including the effects of temperature motions. The Boltzmann equation is solved for this problem, and exact expressions are obtained for the distribution function and dispersion relation. A general feature of the dispersion relation is the existence of gaps in the spectrum at frequencies which are approximately multiples of $\omega_c = eH/mc$. The magnitude of the gap depends on the temperature of the gas, being proportional to it for long wavelengths. This leads to the prediction of selective reflection of waves impinging on a plasma with frequency in the forbidden range. For $ck \gg \omega_p$, ω_c the waves split into approximately longitudinal plasma waves and transverse waves. Detailed analysis is made of the plasma waves for ω_c small and ω_c large. At long wavelengths the

frequency is $\omega^2 \simeq \omega_p^2 + \omega_c^2 + \beta(\kappa T/m)k^2$, where β depends on ω_p and ω_c . For waves near the Debye length the waves are heavily damped. Two simplified treatments of plasma oscillations based on transport equations are compared with the above treatment. Expressions of the form $\omega^2 \simeq \omega_p^2 + \omega_c^2 + \beta(\kappa T/m)k^2$ are obtained where the factor β is independent of ω_c and ω_p . In addition, the transport treatments fail to predict the heavy damping near the Debye length and the existence of gaps in the frequency spectrum.

A.

537.523.4

4400. Streamer breakdown and sparking thresholds. L. B. LOEB. Letter in *Phys. Rev.*, **81**, 287 (Jan. 15, 1951).

This note summarizes the recent work of Fisher, Bederson, *et al.*, on formative times for uniform field breakdown in gases at ~ 1 atmos. pressure. The streamer theory, it is pointed out, needs modification for small overvoltages ($\sim$ a few tenths of one per cent).

J. D. CRAGGS

537.523.5 : 537.525.5 : 537.527.5

4401. Concerning the numerical calculation of temperature distributions in wall-stabilized arc discharges. G. SCHMITZ AND W. HECKER. *Z. Phys.*, **129** (No. 1) 104-7 (1951) *In German*.

Describes a new treatment of the Elenbaas-Heller differential equation describing the equilibrium condition of an arc column. The graphical integration of the equation is simplified and the value of the new method is illustrated with an example.

J. D. CRAGGS

537.523.5 : 537.525.5 : 537.527.5 : 621.325.53

4402. On the theory of a.c. circuits for arc lamps. A. STERN. *Z. angew. Math. Phys.*, **2** (No. 1) 43-9 (1951) *In German*.

The paper describes a theoretical treatment, more complete than those previously published, of the behaviour of p.f.-corrected lamp circuits, including such studies as the variation of circuit current with time.

J. D. CRAGGS

537.523.5 : 537.527.5

4403. Final remarks on the paper of G. Schmitz "On the breadth of the wall-stabilized arc discharge" and on the discussion following it. G. SCHMITZ AND O. KOCH. *Z. Phys.*, **129** (No. 1) 33 (1951) *In German*.

See Abstr. 6524 (1950). A short note referring to various papers (9 in number) on the structure of arc columns, and the views expressed therein.

J. D. CRAGGS

537.525.3

4404. Field intensity as a determinant of negative Joshi effect. N. A. RAMAIAH. *J. Sci. Industr. Res.*, **10B**, 27-30 (Feb., 1951).

Influence of electrode spacing on potential variation of $-\Delta i$ in excited Cl showed its dependence on the surface field intensity (E) in agreement with Joshi's theory that $-\Delta i$ is a space charge effect due to negative ion formation and in an inverse function of E.

A.

537.525.3

4405. Positive coaxial cylindrical corona discharges in pure N_2 , O_2 , and mixtures thereof. C. G. MILLER AND L. B. LOEB. *J. Appl. Phys.*, **22**, 494-503 (April, 1951).

D.C. corona studies were made from 27 mm to 760 mm pressure. Positive corona in pure N_2 does not exist as such. Pre-discharge Townsend currents by photon action on the cathode condition the outer Ni cathode until it spontaneously develops a glow discharge focusing in a spot on the anode wire. The discharge sets in at high potential and persists with lowering by hundreds of volts. Increase in current gives multiple spots and irregular current fluctuations. At lower pressure potential overshoot gradually disappears and the discharge begins as a regular glow discharge. Positive coronas with 1% O_2 show burst pulses at threshold, these being longer in duration (1000 μ sec) than in air because of spread down the wire. At lower pressure burst pulses lasted still longer. Breakdown streamers were observed at lower pressures where the applied potential was adequate. The Townsend equation for current in coaxial geometry applies above threshold both for N_2 and $N_2 + 1\% O_2$. In air the positive corona sequence showing only burst pulses at threshold and breakdown streamers were observed. Burst pulses lasted 2 to 4 times those with 1 mm dia. point-to-plane corona in air owing to spread along the wire, which was less extensive than in 1% O_2 . In pure O_2 the high absorption of photons ionizing the gas led to pre-onset streamers and no burst pulses at thresholds above 200 mm pressure. Below 200 mm streamer pulses and burst pulses, and below 50 mm only burst pulses, were observed. The streamers above 200 mm spread down the whole length of the tube by transparency of O_2 to photons liberating electrons from the Ni cathode cylinder.

A.

537.525.72

4406. Rayleigh afterglow in hydrogen discharges. R. J. LEE AND R. G. FOWLER. Letter in *Phys. Rev.*, **81**, 457-8 (Feb. 1, 1951).

An electrodeless discharge pulse in a ring tube having side-arms is followed by a discharge into these arms proceeding at a speed of about 2×10^6 cm/sec. It is suggested that the afterglow is due to a delay in excitation rather than relaxation of excited atoms.

F. LLEWELLYN JONES

537.527.3/4

4407. The influence of the electrodes in the discharge between coaxial cylinders in compressed air. W. BRIGHT. *C.R. Acad. Sci., Paris*, **232**, 714-16 (Feb. 19, 1951) *In French*.

A study of the effects of electrode surface on the breakdown voltage (b.d.v.) in non-uniform fields. Coaxial cylinders (diameters 13, 6 and 5 mm) of various metals were used at air pressures up to 60 atmos. To summarize: with the maximum field at the cathode, 6 cathode materials showed up to about 20% variations in b.d.v., depending on press., dural giving the lowest b.d.v. and with the maximum field at the anode the range of b.d.v.'s. (at 50-60 atmos.) was slightly higher. These results are briefly discussed.

J. D. CRAGGS

537.527.5

4408. An arc discharge with high loading. H. MAECKER. *Z. Phys.*, **129** (No. 1) 108–22 (1951) *In German*.

A high energy dissipation arc, burning in the eddy region of a water turbine, is described, in which the arc loading can be very high. For example, an arc 13 mm long, 1.4 mm dia. carrying 250 A, had a field strength 240 V/cm, a temp. of 35 000°K (estimated by spectroscopic means and, better, by the drift current equation) and a column loading of 60 kW/cm. The turbine eddy region is described in detail. Spectra of the arc are shown.

J. D. CRAGGS

537.527.5

4409. A contribution to the measurement of temperature in wall-stabilized high-pressure mercury arcs. O. KOCH AND H. DUNSTÄDTER. *Z. Phys.*, **129** (No. 2) 140–7 (1951) *In German*.

Summarizes briefly the various methods available for the measurement of arc temperatures (including gas temperatures, Saha temperatures, etc.), and proceeds to outline the method in which measurements of electron concentration, made from observations of the 2nd-order Stark effect in Hg, are used with Saha's equation to give the arc temperature. Measurements on the Hg lines 4 347, 4 339, 4 916, 5 770 and 5 791 Å are quoted for arcs carrying up to 4 A current at 0.8 and 1.6 atmos. press. in tubes 12 mm in dia. The temperatures thus found were compared with gas temperatures determined with the X-ray absorption method. The latter were consistently lower than the former by up to 800°K at ~6 000°K; part of this difference was due in some cases to the exptl. error.

J. D. CRAGGS

537.529 : 621.315.61

4410. Random noise in dielectric materials. J. H. MASON. Letter in *J. Appl. Phys.*, **22**, 235–6 (Feb., 1951).

Minute discharges between metal electrodes and the surfaces of films of polar plastic materials subject to d.c. potentials of 10–300 V/10⁻³ inch may be the origin of the current fluctuations observed by Boyer [see Abstr. 6483 (1950)]. Electrophotography shows that discharges between dielectric surfaces involve only a small area, and successive discharges at separate sites may occur until the whole area is discharged.

J. H. MASON (R)

X-RAYS 537.531

537.531 : 535.3 : 545.824

4411. X-ray spectrochemistry with bent crystals. Y. CAUCHOIS. *Trans Instrum. Meas. Conf., Stockholm*, 1949, 46–54 (1950) *In French*.

After a description of the different methods used in X-ray spectrochemistry, and the 3 kinds of spectra used (emission, secondary emission and absorption), some examples of the necessary dosage for the different methods and elements are given. Counters give quicker results, and are specially suited for absorption measurements, where the intensities are too small for comfortable photography. As applica-

tions are given, e.g. the detection of W down to concentrations of $\frac{1}{2} \times 10^{-4}$ in minerals, with secondary emission, the control of the separation of Zr and Hf by emission, and the detection of U in other elements by differential absorption.

C. TURNER

537.531 : 535.3 : 545.824

4412. Some examples of applications of bent-crystal spectroscopy. Y. CAUCHOIS. *Trans Instrum. Meas. Conf., Stockholm* (1949) 55–9 (1950) *In French*.

A theoretical explanation of the existence of satellites is followed by a résumé of recent research on isotopes, nuclear reactions in cyclotrons and spectral analysis of neutron beams.

C. TURNER

537.531 : 535.33

4413. Spin doublets in the L-spectrum of platinum. G. B. DEODHAR AND C. MANDE. Letter in *J. Sci. Industr. Res.*, **10B**, 45–6 (Feb., 1951).

537.531 : 535.339

4414. A monochromator for X-ray powder camera. F. M. WRIGHTSON AND I. FANKUCHEN. Note in *Rev. Sci. Instrum.*, **22**, 212–13 (March, 1951).

537.531 : 535.42 : 548.733

4415. The application of Geiger counters in X-ray diffraction. W. J. OOSTERKAMP. *Trans Instrum. Meas. Conf., Stockholm* (1949) 77–8 (1950).

Mentions the circumstances under which a Geiger counter can be employed.

C. TURNER

537.531 : 535.43

4416. A method of determining the wavelength distribution of the X-radiation at a point in a scattering medium. J. R. GREENING. *Brit. J. Radiol.*, **24**, 204–6 (April, 1951).

An experimental method of determining the wavelength distribution of the X-radiation at a point within a block of irradiated material is described. The method consists of measuring the absorption of the radiation in spherical shells of absorbing material placed round a spherical ionization chamber. The absorption curve is converted to that which would have been obtained had it been possible to use flat filters, and this curve is analysed by a method described elsewhere to give the spectral distribution of the radiation. Some illustrative examples are given.

A.

537.531 : 535.43 : 539.153

4417. On the coherent scattering of X-rays by atoms and the influence of shielding by the electrons. I–II. E. ARNOUS. *C.R. Acad. Sci., Paris*, **232**, 693–5 (Feb. 19); 798–9 (Feb. 26, 1951) *In French*.

It is shown how positron theory can be used for treating this problem, with special reference to the “Waller terms” and “Delbrück scattering” in a Coulomb field. The effect of shielding is shown to come from the “one-particle part” of the Coulomb interaction terms, and is expressed in terms of relativistic Dirac wave functions.

W. J. SWIATECKI

537.531 : 535.5

4418. On the production of polarized high energy X-rays. M. MAY AND G. C. WICK. Letter in *Phys. Rev.*, **81**, 628 (Feb. 15, 1951).

The calculated cross-section for polarized X-ray production by impact of high-energy electrons on

nuclei is reported. The optimum angle (with the incident direction) $\theta = mc^2/E$ where E = electron energy.

J. R. MADDOX

537.531 : 548.733

Crystals suitable for double crystal X-ray spectroscopy, 3 to 15 Å. See Abstr. 4904

537.531 : 548.733

4419. Recent developments in bent-crystal technique. Y. CAUCHOIS. *Trans Instrum. Meas. Conf., Stockholm* (1949) 41-5 (1950).

Elastically bent crystals (mica, quartz) are used in spectroscopy for photographic recording, where narrow lines are required, but hard X-rays and γ -rays have an ageing effect on mica. Plastically bent crystals (rocksalt, metals) are used with counters or ionization chambers and as monochromators. A method for making a nearly perfect rocksalt crystal is indicated (a perfect structure gives too low an intensity). Al crystals are more satisfactory, and more easily prepared. Curved crystals form true images by means of X-rays or material waves. These can be photographed, and can give interesting results for slow neutrons.

C. TURNER

537.531 : 621.386.1

4420. Directional distribution of 1 040-keV radiation from a high voltage X-ray tube. N. GOLDSTEIN, U. FANO AND H. O. WYCKOFF. *J. Appl. Phys.*, **22**, 417-18 (April, 1951).

The distribution of the 1 040 keV X-rays emitted in various directions by a h.v. X-ray tube has been measured by means of an indium resonance detector.

A.

CATHODE RAYS . POSITIVE RAYS 537.533/534

537.533

4421. Investigations on the capturing of electrons in a 30 MeV betatron. R. WIDERÖE. Letter in *J. Appl. Phys.*, **22**, 362-3 (March, 1951).

Experiments indicate that the space charge reduction theory can account for the capturing into an orbit. A method for capturing electrons independently of this process, using a rapidly changing magnetic field superimposed on the guide field, is suggested.

J. HUGHES

537.533

4422. Some measurements on a linear accelerator. P. GRIVET AND J. VASTEL. *C.R. Acad. Sci., Paris*, **232**, 809-10 (Feb. 26, 1951) In French.

The first 25 cm section of a travelling-wave linear accelerator, which when complete should give electrons of 4-5 MeV, has been built and tried. With a 2 μ sec pulse of 200 kW peak at 3 000 Mc/s, repeated 100 times/sec, a current of about 10 mA peak at 0.4 MeV is obtained. The energy agrees closely with that theoretically expected.

J. H. FREMLIN

537.533 : 621.384.61

4423. An orbit-bender to assist injection into betatrons. L. DAVIS, JR. *Rev. Sci. Instrum.*, **21**, 971-2 (Dec., 1950).

It is suggested that the fraction of the beam in a

betatron or synchrotron that is lost by striking the injector might be decreased by a suitable transient bending of the steady-state orbit during injection. A.

537.533 : 621.384.61

4424. A flux-forced field-biased betatron. E. C. GREGG. *Rev. Sci. Instrum.*, **22**, 176-82 (March, 1951).

The design, construction and operational performance of a flux-forced field-biased betatron at Case Institute of Technology are described. Limitations due to flux forcing and its effect on the time variation of the equilibrium orbit are also discussed. A.

537.533 : 537.523.2/4

4425. The role of the electrodes in the mechanism of initiation of spark discharges in gases. F. LLEWELLYN JONES, E.-T. DE LA PERRELLE AND C.-G. MORGAN. *C.R. Acad. Sci., Paris*, **232**, 716-18 (Feb. 19, 1951) In French.

The emission of electrons from cold cathodes of Ni and W in air at atmospheric pressure, under macroscopic electric fields of the order of 10^5 V/cm, was measured for different electrode surface states. The emission was enhanced by oxidation, and in certain cases followed a field law. The influence of residual positive ions in initiating successive sparks was also studied.

F. LLEWELLYN JONES

537.533.7

4426. Čerenkov radiation counter for fast electrons. J. MARSHALL. Letter in *Phys. Rev.*, **81**, 275-6 (Jan. 15, 1951).

537.533.72

4427. The ketron: a magnetic spectrometer with improved focusing. B. S. DZHELEPOV AND A. A. BASHILOV. *Izv. Akad. Nauk, SSSR, Ser. Fiz.*, **14** (No. 3) 263-98 (1950) In Russian.

This is a 180° deflection focuser in which the field H , normal to the median plane ($z = 0$), is a function of y only, where source and image are at ($x = \pm \rho_0$, $y = 0$). For $y \leq \rho_0$, $H = (H\rho)/\rho_0$. For $y > \rho_0$, $H(y)$ may be so chosen that all rays in the median plane and with $90^\circ \leq \alpha \leq 180^\circ$ are perfectly focused, where $\tan \alpha = dy/dx$ at $x = -\rho_0$. This arrangement was proposed and first realized by Korsunsky, Kelman and Petrov [*J. Exp. Theor. Phys.*, **14** (No. 10-11) 394 (1944)] who found an approximate numerical solution for $H(y)$. A more exact solution has now been found [but is not given]. A spectrometer has been constructed with $\rho_0 = 8$ cm and pole pieces 34×24 cm. Relative measurements to 0.1% show close agreement with the required field. A figure shows the calculated focusing [the method of calculation is not given] of a point source at ($x = -\rho_0$, $y = 0$, $z = 0$) for rays having $\alpha = 90^\circ$, 120° and 135° and $\epsilon_0 = 0^\circ$, 3° and 6° , where ϵ_0 is their initial inclination to the median plane. Comparison is shown between calculated and observed line shape at a resolving power (r.p.) of 0.5%. At r.p. of 1% the following dimensions were used: $90^\circ \leq \alpha \leq 120^\circ$; $-6^\circ \leq \epsilon_0 \leq 6^\circ$; source and slit widths 0.8 mm; slit length 20 mm; source length 16 mm. The r.p. could be raised to 0.5% by using a second counter in coincidence, after an additional slit. For r.p. of 0.15% $-1^\circ \leq \epsilon_0 \leq 1^\circ$, source and slit widths 0.1 mm, slit height 10 mm, α unchanged; solid angle was then

1.5×10^{-3} of 4π . Use cannot be made of $\alpha \gg 120^\circ$ because image width Δx then increases too rapidly with ϵ_0 . H was measured absolutely and 8 accurately known ($H\rho$) values then determined; the results are tabulated. The mean error in the absolute field measurements was hence found to be $+0.3\%$. After multiplying all experimental values of ($H\rho$) by 0.997, the mean absolute error was 0.13% . J. C. E. JENNINGS

537.533.72

4428. Electron optical disk. L. MARTON AND J. A. SIMPSON. Note in *Rev. Sci. Instrum.*, **21**, 1027-8 (Dec., 1950).

Describes an electron optical device for the study of the behaviour of electron beams, which is analogous to the optical disk used in teaching elementary physics. The beam of electrons to be studied grazes a large fluorescent screen whose position in the vacuum can be varied. The traces of the beam on this screen under various conditions provide the necessary information. Examples are given. J. THEWLIS

537.533.72

4429. On the experimental determination of fields by Marton's electronic method. F. BERTEIN. *C.R. Acad. Sci., Paris*, **232**, 491-3 (Feb. 5, 1951) *In French*.

The results obtained by Marton's electronic shadow method for the exploration of electric or magnetic fields may be simply interpreted if the action of the field is regarded as equivalent to that of a small weak lens. J. THEWLIS

537.533.72

4430. On the theory of independent electrostatic lens with thick central electrode. E. REGENSTREIF. *C.R. Acad. Sci., Paris*, **232**, 604-6 (Feb. 12, 1951) *In French*.

An extension of the author's theory for lenses with thin electrodes. J. THEWLIS

537.533.72

4431. Double focusing with wedge-shaped magnetic fields. M. CAMAC. *Rev. Sci. Instrum.*, **22**, 197-204 (March, 1951).

Geometric focusing in two directions for charged particles of a single energy is produced with a wedge-shaped magnetic field. The uniform field in the gap focuses in the plane of the pole faces, while the fringe fields focus perpendicular to the pole faces. With a single wedge the energy dispersion is too large for the weak electron intensities available with the source; i.e. for a reasonable size slit at the collector only a narrow energy width and, thus, a small number of electrons is accepted. With the use of two wedge-shaped fields the energy dispersion can take a wide range of values, even zero in the first order. General formulae for either one or two magnet systems are derived for the focusing conditions, the energy dispersion, the second-order beam spread, and the effect of source width. These formulae are then applied to two special cases from which practically all design requirements can be obtained. Finally, a design is recommended for which the following requirements are fulfilled: 5% energy spread in an inch collector slit, large angular collection and the same size source and collector slits. A.

537.533.72 : 621.385.833

4432. The optical properties of the electrostatic "einzellinse" with a thick central electrode. E. REGENSTREIF. *C.R. Acad. Sci., Paris*, **232**, 710-12 (Feb. 19, 1951) *In French*.

The expressions developed in earlier papers [Abstr. 7297-8 (1950)] are extended to the case of the thick centre electrode, and it is shown that absolute values of converging power considerably greater than those for thin centre electrodes can be obtained.

A. H. W. BECK

537.533.72 : 621.385.833

4433. On the spherical aberration of electron emission systems. O. KLEMPERER AND Y. KLINGER. *Proc. Phys. Soc., Lond. B*, **64**, 231-3 (March, 1951).

Spherical aberration coefficient and source diameter have been measured for a "hairpin" emission system. Both have been found to be smaller than the corresponding values of various other emission systems. A.

537.533.72 : 621.385.833

4434. Investigation of electron optical properties of an electrostatic focusing system. W. E. SPEAR. *Proc. Phys. Soc., Lond. B*, **64**, 233-43 (March, 1951).

It is shown that the combination of paraxial ray tracing and a dynamical determination of the electron trajectories in the cathode region leads to a complete analysis of electron-optical immersion systems, once the potential distribution is known. The method is applied to an electrode arrangement recently described [Abstr. 3566 (1951)]. In particular it is shown that a demagnified image of the emitting area of the hairpin filament is produced close to the anode, if the outer electrode of the system is at cathode potential. A magnified image is formed near the emitter if this electrode is at anode potential. The results are in good agreement with experiment. A discussion of aberration and crossover is included. A.

537.533.72 : 621.385.833

4435. Electron-optical systems with helical axis. D. GABOR. *Proc. Phys. Soc., Lond. B*, **64**, 244-55 (March, 1951).

As the chromatic error of focus has the same sign in all electron lenses with straight axis, achromatic combinations do not exist. It is shown, however, that systems with curved axes can be designed which are equivalent to centred systems in the Gaussian approximation, but have chromatic error of opposite sign, and thus may be useful as correcting elements. Systems with a helical axis, with a helical electrostatic field so shaped as to eliminate first-order astigmatism, have particular advantages. In such systems images of unit magnification are produced at equal intervals along the helical axis. Under certain conditions the transverse chromatic shift can be made zero in every second, or third, . . . image, while the longitudinal error of focus can be given any negative value by suitable choice of the pitch. Such systems may find application in secondary emission and dark-field electron microscopes, and particularly in diffraction microscopy. At a certain pitch the chromatic error becomes infinite. This system is particularly easily realized by means of two coaxial cylindrical electrodes. It is useless as a chromatic corrector, but may find applications as a velocity spectrograph. A.

537.533.72 : 621.385.833

4436. Contribution to the study of a cylindrical electromagnetic electron lens. J. A. GÓMEZ GARCÍA. *An. Real Soc. Esp. Fis. y Quím.*, 47, 15–28 (Jan.–Feb., 1951) In Spanish.

Conditions of bidimensionality are imposed on scalar and vector potentials by selecting an appropriate system of reference. Formal expressions for V and $\vec{A}$ are obtained in the form of potential series of y . By applying the minimum action principle differential equations of the semiparaxial trajectories are obtained. These equations are solved by the constant variation method. Agreement between the equations obtained and those of Gratsiatos is shown for paraxial trajectories. A.

537.533.72

4437. An exposure meter for the electron microscope. E. H. FREI AND F. L. HIRSHFELD. *Rev. Sci. Instrum.*, 22, 231–2 (April, 1951).

A simple exposure meter has been developed which measures directly the beam current reaching the fluorescent viewing screen of the electron microscope. By its use, the characteristic curve of a Kodak lantern slide plate has been plotted at constant intensity of electron beam. The value of beam intensity given by the exposure meter is confirmed by direct counts of electron tracks in the developed emulsion. A.

537.533.72

4438. On the question of rendering atomic dimensions visible in the electron microscope. L. WEGMANN. *Helv. Phys. Acta*, 24 (No. 1) 63–71 (1951) In German.

In principle it should be possible to observe atoms in the electron microscope by cutting off all electrons emerging from the object except those within a very narrow angle of scattering. The practical difficulties involved, however, are such as to make it unlikely that the aim will be realized in the near future. J. THEWLIS

537.533.72 : 621.385.833

4439. The position of electron microscopy in Germany. E. BRÜCHE. *Trans Instrum. Meas. Conf., Stockholm* (1949) 209–15 (1950) In German.

Reviews the development of electron microscopy in Germany before and after the war and discusses some of the details of the A.E.G.–Zeiss electrostatic electron microscope. A brief survey of the capabilities of electron microscopy is also given. J. THEWLIS

537.533.72

4440. Ring focusing in a thin lens beta-ray spectrometer. W. W. PRATT, F. I. BOLEY AND R. T. NICHOLS. *Rev. Sci. Instrum.*, 22, 92–6 (Feb., 1951).

The existence of a ring-shaped constriction in the electron beam of a thin lens beta-ray spectrometer is demonstrated experimentally by a photographic film method. Making use of a photographic mapping of the beam, an annular baffle is designed. Optimum relations between annular width, solid angle, and counter window diameter are investigated. A comparison of this type of baffle system with the original baffle system shows that at 2.5% resolution the spectrometer transmission may be increased by a factor of 2 by the use of an annular aperture in the region of beam constriction. A.

537.533.72

4441. The use of three long rectangular coils for neutralization of the earth's magnetic field in a lens-type beta-ray spectrometer. S. K. HAYNES AND J. W. WEDDING. *Rev. Sci. Instrum.*, 22, 97–101 (Feb., 1951).

Accurate neutralization of the earth's magnetic field B_e over a long cylindrical region is necessary to extend the energy range of a magnetic-lens spectrometer to electrons of very low energy. Axial conductors spaced 45° apart on the surface of a circular cylinder of radius a are used to approximate a $\cos \theta$ distribution. The conductors at $\pi/2$ are missing since $\cos \theta$ vanishes. There are $1/\sqrt{2}$ as many conductors at $\pm\pi/4$ and $\pm 3\pi/4$ as at 0 and π . In the plane transverse to the length of the cylinder, the radial variation of the compensating field is given approximately by the term $B_e(r/a)^6 \cos 6\theta$. Beta-rays of a few kilovolts energy, which reach a maximum radius $a/2$, experience an average residual field of about 0.1% of B_e which produces a deflection of about 0.1 mm for a 1-meter spectrometer. The construction of the coils is described. A.

537.533.72

4442. Graphical determination of transmission curves for certain magnetic lens beta-ray spectrometers. J. F. PERKINS AND A. W. SOLBRIG, JR. *Rev. Sci. Instrum.*, 22, 173–5 (March, 1951).

A graphical method is described for determining the transmission curve of a point source on the axis of a thick magnetic lens beta-ray spectrometer with ring-focusing baffles. The method is applicable to spectrometers in which the magnetic field in the region between the ring-focus position and the detector is weak compared with the maximum field in the instrument. It requires the computation of only a few electron paths because the plot of the radial co-ordinate against the axial co-ordinate is very nearly linear beyond the ring-focus position. Transmission curves are drawn for two different baffle systems in a particular instrument, and it is shown that the low energy side of the curve may be steepened considerably by the use of two outer baffles and a properly located counter aperture. A.

537.533.74

4443. Differences in the scattering of electrons and β -rays. F. SUZOR AND G. CHARPAK. *C.R. Acad. Sci., Paris*, 232, 720–2 (Feb. 19, 1951) In French.

Continuation of previous work [Abstr. 3735 (1951)]. Evidence is produced that the observed difference in back scattering of electrons and β -particles is not due to the soft components of the latter. B. ROSE

537.534 : 537.3 : 621.317.31

4444. A current integrator. G. M. B. BOURICUIS AND F. C. SHOEMAKER. *Rev. Sci. Instrum.*, 22, 183–4 (March, 1951).

A current integrator has been developed which is dependable to $\pm 0.1\%$ or better for ion-beam currents of a few $\mu A \times 10^{-2}$ or greater. A.

537.534 : 621.317.2 : 621.384.6

4445. The high voltage apparatus at the Ivry laboratory for atomic synthesis: accelerators. J. SOMMERIA.

J. Rech. Cent. Nat. Rech. Sci., No. 13, 247-63 (1950)
In French.

Two accelerator tubes of 600 kV, one started before the war, and a more recent one of 900 kV, are described. An earlier paper [*J. Rech. Cent. Nat. Rech. Sci.*, No. 7 (1948)] described the h.t. generators. The first 600 kV tube uses a h.v. ion source (50 kV) giving 500 μ A total current, 55% protons. The second uses a 200 V Heil-Von Ardenne type source giving 700 μ A, 70% protons or deuterons. The 900 kV tube uses a somewhat improved h.v. source. In each case the electron-optical system and target arrangements are described. Finally an earlier impulse-generator for 3 MeV electrons is briefly described.

J. H. FREMLIN

537.534 : 621.384.61

4446. An air-cored synchro-cyclotron for 400 MeV protons. L. RIDDIFORD. *Proc. Phys. Soc., Lond. B*, **64**, 218-24 (March, 1951).

It is considered that the most reasonable proposition for accelerating protons to very high energies, using an instrument which employs a magnetic field produced by an air-cored coil, is to operate the machine as a synchro-cyclotron. An investigation of the energies available from such accelerators for given amounts of stored magnetic-field energy is carried out on the basis that the limit is set by the mechanical forces exerted on the coil. It is shown that the power requirements are comparable with those of large iron-cored accelerators at present under construction. In a machine with a useful orbit of radius 11.8 cm, it is possible to provide a field of 2.7×10^5 gauss over the circle enclosed by that orbit, so that protons would be accelerated to an energy of 400 MeV.

A.

537.534 : 621.396.615 : 621.384.61

4447. The design of cyclotron oscillators. J. BACKUS. *Rev. Sci. Instrum.*, **22**, 84-92 (Feb., 1951).

The procedure used to design the 60 in cyclotron oscillator at Berkeley is described. The procedure consists in assuming the cyclotron and associated circuits to be oscillating on one of normal modes of vibration of the electrical circuit and adjusting the circuit so that the proper voltages to drive the oscillator tube are obtained. The procedure is illustrated by numerical examples taken from the original design data.

A.

537.534.72

4448. An electron current regulator for mass spectrometer ion sources. V. J. CALDECOURT. Note in *Rev. Sci. Instrum.*, **22**, 58-9 (Jan., 1951).

537.534.72

4449. On the ion optics of mass spectrometers with simple magnetic deflection. C. CASSIGNOL AND G. NIEF. *C.R. Acad. Sci., Paris*, **232**, 615-17 (Feb. 12, 1951) In French.

Considers means of minimizing aberrations, and concludes that the usual way in which the resolution of a mass spectrometer is defined errs on the pessimistic side.

J. THEWLIS

537.534.74

4450. Experiments on elastic p - p scattering in the energy range 120 to 345 MeV. O. CHAMBERLAIN, E. SEGRÈ AND C. WIEGAND. Letter in *Phys. Rev.*, **81**, 284-5 (Jan. 15, 1951). See also Abstr. 8055 (1950).

537.534.74

4451. Erratum: Study of the multiple scattering of fast charged particles in a gas and its role in the interpretation of cloud-chamber tracks. G. GROETZINGER, M. J. BERGER AND F. L. RIBE. Letter in *Phys. Rev.*, **81**, 456 (Feb. 1, 1951). See Abstr. 5050 (1950).

537.534.74

4452. Proton-proton scattering at 3.4, 6.8 and 7.5 MeV. J. ROUVINA. *Phys. Rev.*, **81**, 593-601 (Feb. 15, 1951).

Using a gas target and photographic plates as detectors, absolute differential p - p scattering cross-sections in the angular range of 45° to 10° at 6.8 and 7.5 MeV were measured with an accuracy of 2%. The apparatus was checked by obtaining data at 3.4 MeV in the angular range of 15° to 45° . The data obtained at this energy range were in agreement with the precise Van de Graaff data. The 6.8 and 7.5 MeV data show that the S -wave cross-sections at these energies are consistent with the extrapolation of the precise Van de Graaff data to this energy region. No indication of a P -wave effect was observed in either the low or high energy data.

A.

537.534.74

4453. Multiple traversals of high energy particles in a cyclotron beam through thin targets. W. J. KNOX. *Phys. Rev.*, **81**, 693-7 (March 1, 1951).

An experimental determination has been made of the average number of times that 340 MeV protons traverse various targets in the Berkeley 184 in cyclotron. The numbers range from slightly above 1 for a 1 in thick Cu target to about 15 for an Al target 0.0015 in thick. The results are compared with calculated values based on multiple scattering in the target and oscillations of the particles in the cyclotron. It is believed that the results can be adapted to apply to various particles of different energies in the cyclotron. Calculations are made on the energy distribution of beam particles which cause reactions in a target, and distributions are shown for several targets. The selection of targets for the production of high-energy neutron beams is discussed. Histograms are presented showing the depth of radial penetration of the 340 MeV proton beam into various targets.

A.

537.534.74

4454. On the hard sphere model of the nucleon. R. JASTROW. Letter in *Phys. Rev.*, **81**, 636 (Feb. 15, 1951).

Calculated cross-sections for p - p scattering by a law of interaction with a hard repulsive core of radius 0.6×10^{-13} cm shows agreement with experiments at 30, 100, 250, 340 MeV. See also Abstr. 3331 (1951).

W. J. SWIATECKI

537.534.74

4455. Proton-proton scattering at 5 MeV. K. B. MATHER. *Phys. Rev.*, **82**, 133-40 (April 15, 1951).

A scattering chamber has been constructed which employs a number of radial slit units arranged at various angles with respect to the collimated beam of protons. A photographic plate is placed behind each slit unit and the tracks of protons which are scattered into the plate can be counted. To obtain cross-sections from this apparatus the number of tracks per unit area must be determined. Protons were scattered from

H gas at approximately 1.5 cm Hg pressure. Advantages of the design were relatively simple geometry, data obtained simultaneously at all angles, almost complete freedom from impurity-scattering, and short cyclotron running times. The differential cross-sections were measured for 5.07 MeV protons from 14° to 150° in the centre-of-mass system. The results indicate an *S*-wave phase shift of $54.5 \pm 0.6^\circ$ and a repulsive *P*-wave phase shift of $0.05 \pm 0.09^\circ$. They are therefore quite consistent with pure *S*-wave scattering. A.

537.534.75

4456. Stopping power and energy loss for ion pair production for 340-MeV protons. C. J. BAKKER AND E. SEGRÈ. *Phys. Rev.*, **81**, 489–92 (Feb. 15, 1951).

The relative stopping powers for 300 MeV protons of H, Li, Be, C, Al, Fe, Cu, Ag, Sn, W, Pb and U have been measured. The energy spent per ion-pair production in the gases H_2 , He, N_2 , O_2 , Ne, A and air at 340 MeV proton energy has also been measured. A.

537.534.79

4457. Theory of the polarization of canal rays. II. Calculation of the polarization values and comparison with measurements. G. ECKER. *Z. Phys.*, **129** (No. 2) 161–89 (1951) *In German*.

For Part I see Abstr. 2761 (1951). The polarization values for the experimentally investigated series of the alkalis and of H are expressed as functions of tabulated quantities. A series of equations is derived that permit of evaluation by calculating machines. The measure of polarization is the ratio of the intensity of the polarized light in the direction of the canal rays to the intensity measured in a perpendicular plane. With H, all experiments refer to the lines of the Balmer series. Four different types of polarization are discussed, namely those by means of charged particles, of neutral atoms, of charged particles and neutral (foreign) atoms and, lastly, of charged particles and neutral (identical) atoms. In the first case, the same formulae express the excitation due to charged atoms and charged particles. The polarization of the dying-away light becomes a function of the cathodic distance. The last two phenomena describe an additional disturbance between excitation and light emission. This results in the occupation probabilities becoming a function of both the dying-away process and the disturbance. Main series: the excitation of the lines of the main series decreases with the increasing velocity of the charged particle and changes from longitudinal to transverse polarization (cross polarization); with ion excitation the polarization increases with the increasing atomic number of the exciting atom. Excitation due to charged particles and foreign neutral atoms does not influence the polarization. Secondary series: charged particles exercise an increasing influence on the polarization phenomenon with the density of the particles increasing, while increasing velocity reduces this influence; the polarization phenomena of the Balmer series are manifold. Those phenomena of the Stark–Lunelund effect that have been observed with a high degree of reliability, are found to be described correctly by the theory. Cause and dependence of the polarization on various factors are explained by the theory. In all cases there is good quantitative agreement.

W. SUMMER

DISCHARGE TUBES . COUNTERS 537.54

537.542

4458. A magnetic ion source of the Heil-type. J. KISTEMAKER AND C. J. ZILVERSCHOON. *Physica*, **17**, 43–9 (Jan., 1951).

Construction and technical difficulties of a Heil source are given, together with some preliminary measurements. The efficiency of the Finkelstein and the Heil sources are compared. The electrical yield of the H-source is 40 times smaller than the yield of the F-source. A.

537.542

4459. The elimination of the end effects in counters. A. L. COCKROFT AND S. C. CURRAN. *Rev. Sci. Instrum.*, **22**, 37–42 (Jan., 1951).

The operation of cylindrical proportional and Geiger counters near the ends of the wire is examined closely by means of thin sheets of soft homogeneous X-radiation. It is found that small field-adjusting tubes, fitted over the usual grounded guard tubes (where these are required) and maintained at the potential appropriate to their diameter, reduce the end effects to negligible proportions. The computed field distribution is thus confirmed experimentally. Both theory and practice show that the concentric field-adjusting and guard tubes need not be longer than a radius of the counter. The method can be used in designing counters of very short operating length. In practice the technique is simple and it can be applied to the construction of ionization chambers (pulse or steady current type), proportional counters with constant gas gain along the whole wire, and Geiger counters. It insures in each case a precisely defined counting volume. A.

537.542

4460. A note on the successive peaks of spurious counts in G–M tubes. J. E. KUPPERIAN, JR., P. C. MURRAY AND H. FEENY. Note in *Rev. Sci. Instrum.*, **22**, 60–1 (Jan., 1951).

537.542

4461. Geometrical efficiencies of end-window G–M. counters. G. B. COOK, J. F. DUNCAN AND M. A. HEWITT. *Nucleonics*, **8**, 24–7 (Jan., 1951).

The variation of efficiency of detection of a point source displaced perpendicular to the axis of the counter is deduced from the solid angles subtended at the point by the counter window. Curves are given relating efficiency to d/r for various h/r , where r is the counter window radius, h the axial distance of the point source from the window and d the displacement perpendicular to the axis. Comparisons are made with experimental results and discrepancies are discussed. The efficiencies for detecting disk-shaped sources are deduced. L. R. SHEPHERD

537.542

4462. Design characteristics of air proportional counters. A. C. SHECKLER. *Nucleonics*, **8**, 44–9 (Jan., 1951).

The variation of counting efficiency of air-filled multi-wire proportional counters, with the dimensions of the counter, have been determined experimentally. These experiments have been accompanied by electrolytic tank studies of potential distributions

for several counter cross-sections. Variation in sensitivity is due to electron attachment, which removes electrons formed in ionizing events in regions of low gradient. Microphonic pulses can be largely eliminated by the adoption of an antimicrophonic collecting wire mounting which is described. Excessive noise is possible in high-grade insulators and an example in polystyrene is cited.

L. R. SHEPHERD

537.542

4463. On the existence of a discharge-spread region in a counter tube with a pure vapour filling. H. NEUERT. *Z. Phys.*, **129** (No. 1) 27-32 (1951) *In German*.

Describes the processes involved in the spread of the discharge in a Geiger counter, i.e. the effect of the photo-ionizing radiations produced near the wire, probably produced by recombination in the manner described by Hopwood [Abstr. 288 (1950)].

J. D. CRAGGS

537.542 : 621.318.572 : 621.387.4

4464. Nuclear particle and radiation detectors. I. Ion chambers and ion-chamber instruments. D. TAYLOR AND J. SHARPE. *Proc. Instn Elect. Engrs, Pt II*, **98**, 174-90 (April, 1951) [Reprint No. 1077].

For abstract see Abstr. 1123 (1951).

537.542 : 621.318.72 : 621.387.4

4465. Nuclear particle and radiation detectors. II. Counters and counting systems. J. SHARPE AND D. TAYLOR. *Proc. Instn Elect. Engrs, Pt II*, **98**, 209-30 (April, 1951) [Reprint No. 1078].

For abstract see Abstr. 1124 (1951).

537.542 : 621.387.424

4466. The development of end-window Geiger-Müller counter tubes. R. O. JENKINS. *Proc. Instn Elect. Engrs, Pt II*, **98**, 231-6 (April, 1951) [Reprint No. 1012]. For abstract see Abstr. 5895 (1950).

537.542 : 621.387.424 : 621.317.39

4467. A survey equipment using low-voltage halogen-quenched Geiger-Müller counters. E. FRANKLIN AND W. R. LOOSEMOORE. *Proc. Instn Elect. Engrs, Pt II*, **98**, 237-44 (April, 1951) [Reprint No. 1031].

For abstract see Abstr. 7329 (1950).

537.542

4468. Proportional counters. III. S. A. KORFF. *Nucleonics*, **8**, 38-43 (Jan., 1951).

See Abstr. 3585 (1951) for Part II. Discusses, very briefly, the requirements of electronic equipment, used with proportional counters.

L. R. SHEPHERD

537.542 : 537.591

4469. A cloud-ionization chamber for the study of cosmic-ray nuclear interactions. H. W. LEWIS, W. W. BROWN, D. O. SEEVERS AND E. W. HONES. *Rev. Sci. Instrum.*, **22**, 259-63 (April, 1951).

A combination cloud chamber and ionization chamber in which the gas (A at 51 lb/in⁻² saturated with iso-amyl alcohol) is common to both chambers is described. The ion chamber, a 3½ in dia. brass cylinder 8 in in length open at both ends and having a 1/16 in central wire, is mounted coaxially with the cloud chamber, which has a useful rectangular volume 10 in × 10 in × 8 in. A burst occurring in the ion chamber generates a pulse which is used to trigger the

expansion mechanism. Rapid reduction of the cylinder voltage from -1 800 V to ground, after electron collection is over, prohibits any appreciable motion of positive ions and thus permits observation of the tracks of the burst producing particles. In preliminary tests at sea level, cosmic-ray bursts from cascade showers and from stars occurring in the wall (up to 10 prongs) and in the gas (up to 5 prongs) of the ion chamber have been observed.

A.

537.542

4470. Electron energy studies with the anthracene scintillation counter. J. I. HOPKINS. *Rev. Sci. Instrum.*, **22**, 29-33 (Jan., 1951).

Using a β-ray lens spectrometer to supply electrons of a given energy, a study of the response of the anthracene scintillation counter to monoenergetic electrons has been made. It has been found that pulse height varies linearly with energy from 125 to 3 200 keV, but below 125 keV the pulse height varies less rapidly with energy. The differential counting rate distribution for given energy settings of the lens spectrometer were found to follow a Gaussian distribution and on the average 3.3 keV to be required to produce one effective photo-electron at the cathode. When Morton's correction for dynode losses is applied, it is found to require 2.5 keV for the production of one photo-electron at the cathode or that 400 electrons enter the multiplier per MeV of incident electron energy. This is in agreement with the 420 electrons per MeV obtained by direct measurement. Assuming a 10% photo-electric efficiency at the photo-sensitive surface, it appears that the efficiency of anthracene for the conversion of incident electron energy into photon energy is of the order of 1-2%.

537.542 : 621.383.8 : 621.318.572

4471. Scintillation counting equipments. R. B. OWEN AND E. A. SAYLE. *Proc. Instn Elect. Engrs, Pt II*, **98**, 245-51 (April, 1951) [Reprint No. 1035].

For abstract see Abstr. 8827 (1950).

537.542 : 621.318.572

4472. Coincidence measurements. T. HVINDEN. *Forsvarets ForsknInst. Arb.*, **2**, 61-72 (1948-49) *In Norwegian*.

The coincidence method is outlined and its applications and advantages are stated. The Rossi circuit is shown in diagram and the effect of the circuit time constant on resolution time is discussed. The use of a discriminator for controlling the resolution time is explained and the delay, or time lag between two successive pulses, inherent in the nature of the counter, is discussed in relation to the speed of counting and the probable number of pulses lost, and the total time that should be allotted to a measurement to ensure a certain accuracy. Cyclotron-recording may be used, and an alternative method using an E.B. call-counter with scaling circuit is explained.

J. A. WILCKEN

537.542 : 621.318.572

4473. Distributed coincidence circuit. C. WIEGAND. *Rev. Sci. Instrum.*, **21**, 975-6 (Dec., 1950).

A coincidence circuit using the travelling wave principle as applied to distributed amplification is described. The resolving time is about 10⁻⁸ sec when the device is used in connection with scintillation detectors.

A.

537.542 : 621.318.572

4474. Zero inefficiency anticoincidence circuit. M. DEGALLIER. Note in *Rev. Sci. Instrum.*, **21**, 1025 (Dec., 1950).

537.542 : 621.318.572

4475. A counting rate meter of high accuracy. E. H. COOKE-YARBOROUGH AND E. W. PULSFORD. *Proc. Instn Elect. Engrs, Pt II*, **98**, 191-5 (April, 1951) [Reprint No. 1015].

For abstract see Abstr. 6582 (1950).

537.542

4476. A continuously sensitive cloud chamber. T. S. NEEDELS AND C. E. NIELSEN. *Rev. Sci. Instrum.*, **21**, 976-7 (Dec., 1950).

A particularly simple cloud chamber is described that is continuously sensitive to ion tracks. The chamber operates on the principle of vapour diffusion from a hot to a cold surface. The sensitive region is a shallow horizontal layer near the cold surface. The chamber has been placed in a magnetic field and curved tracks of β -particles from a radioactive source have been photographed. Pictures of such electron tracks are shown.

A.

537.542 : 621.318.572

4477. Single-channel analyzer. J. E. FRANCIS, JR., P. R. BELL AND J. C. GUNDLACH. *Rev. Sci. Instrum.*, **22**, 133-7 (March, 1951).

A single-channel analyser has been built for measuring the pulse spectrum from proportional and scintillation counters; it counts the number of pulses whose heights lie between E and $E + \Delta E$. The interval ΔE or "window width" is constant within $\pm 1.2\%$ for all values of E between 0 and 90 V. Curves are presented which show that the analyser performs satisfactorily on the random distribution of pulse amplitudes obtained from counters.

A.

537.542 : 621.318.2

4478. Design of permanent magnets for cloud-chamber work. R. P. SHUTT AND W. L. WHITEMORE. *Rev. Sci. Instrum.*, **22**, 73-6 (Feb., 1951).

For the investigation of radiations of high energies, one can place a magnetic field between two cloud chambers. For a given flux of radiation to be observed, the air gap of the magnet in this arrangement can be made much smaller than when a cloud chamber is mounted between the pole pieces of a magnet. For small gap lengths, a permanent magnet is capable of producing a strong magnetic field. In order to assure most efficient distribution of the magnetic alloy used, model experiments were performed. A calculation shows that, if the variables are chosen appropriately, a single constant can be adjusted so that all the experimental results can be fitted to a universal function within a few %. By means of a co-ordinate transformation of the universal function, one can predict field intensities or determine optimum constructions of a large variety of permanent magnets. Reasonable accuracy can be expected as long as the ratio of gap length to linear dimension of the pole faces is $< \frac{1}{4}$. The method has been applied to the construction of a large permanent magnet to be used for a study of the anomalous scattering of cosmic-ray mesons.

A.

537.543

4479. The cathode field in diodes under partial space-charge conditions with initial velocities. A. O. BARUT. Letter in *Phys. Rev.*, **81**, 274-5 (Jan. 15); **82**, 554 (May 15, 1951).

537.543 : 621.385.16.029.6

4480. Analysis of synchronous conditions in the cylindrical magnetron space charge. H. W. WELCH, JR. AND W. G. DOW. *J. Appl. Phys.*, **22**, 433-8 (April, 1951).

In the multianode cylindrical magnetron there exist favoured phase velocities of the electromagnetic wave around the interaction space between anode and cathode. These velocities are characteristic of the resonant system attached to the anode segments. In the oscillating magnetron the electronic space charge within the interaction space is presumed to maintain synchronism with one of these velocities. Certain of the conditions of synchronism which can be discussed analytically are treated. The results, although based on restrictive assumptions, can be used in the interpretation of magnetron operation and in predicting regions of efficient behaviour.

A.

537.543 : 621.385.2

4481. The transit time, electron paths, cathode field strength and potential in a space-charge diode for any initial electron velocity and direction, and current. A. O. BARUT. *Z. angew. Math. Phys.*, **2** (No. 1) 35-42 (1951) *In German*.

A new method for the solution of the non-linear differential equation describing the electron velocity in a planar diode with space charge (partial or complete). The treatment enables electron trajectories and transit times to be calculated.

J. D. CRAGGS

IONIZATION . THERMIONICS 537.56/58

537.56 : 535.338.1

4482. On the light emission accompanying electrical excitation of the rare gases—the case of helium. M. BAYET. *C.R. Acad. Sci., Paris*, **232**, 612-13 (Feb. 12, 1951) *In French*.

A brief discussion of recombination processes possible in the afterglows of He and Ne. The formation of He₂ molecules is briefly described and the importance of the falling electron temperature in increasing the recombination coefficients is mentioned.

J. D. CRAGGS

537.563 : 545.827

4483. The mass spectra of C₁-C₄ monodeutero paraffins. D. P. STEVENSON AND C. D. WAGNER. *J. Chem. Phys.*, **19**, 11-16 (Jan., 1951).

The magnetically-scanned mass spectra of methane-*d*, ethane-*d*, propane-1-*d*, propane-2-*d*, *n*-butane-1-*d*, *n*-butane-2-*d*, *i*-butane-1-*d*, and *i*-butane-2-*d*, characteristic of 75 V ionizing electrons and 75°C are given and compared with the mass spectra of the corresponding hydrocarbons. A qualitative account of the origin of the isotope effects in mass spectra is given. The two-parameter empirical theory of isotope effects proposed by Evans, Bauer and Beach is applied to the mass spectra of the methanes and ethanes and

found to be inadequate for the prediction of mass spectra for accurate analysis of isotopic mixtures. It is found, however, that for certain electron-impact induced processes, such as $RH + e^- \rightarrow R^+ + H + 2e^-$, the effective values of the parameters, Γ and π , are essentially equal for the monodeutero C_1 through C_4 paraffins. It is found that in certain states of the paraffin molecule-ions the hydrogens are sufficiently mobile to undergo very extensive intra-molecular redistribution in the short life of the molecule ion before they dissociate. A.

537.563 : 545.827

4484. On the mass spectra of propanes and butanes containing C^{13} . D. P. STEVENSON. *J. Chem. Phys.*, **19**, 17-21 (Jan., 1951).

A mass spectrometric method of analysis of C^{13} enriched samples of paraffins, both with respect to the gross concentrations of $-C_0^{13}$, $-C_1^{13}$ and $-C_2^{13}$ species and the concentration of C^{13} isomeric species is described, with particular reference to samples of propane-1 — C^{13} , propane-2 — C^{13} , *n*-butane-1 — C^{13} , *n*-butane-2 — C^{13} , *i*-butane-1 — C^{13} , and *i*-butane-2 — C^{13} prepared in connection with tracer studies of certain paraffin reactions. The isotope effects on the dissociation probabilities of certain states of the propane and butane molecule-ions are discussed in terms of a simple qualitative model. Of particular interest is the observation that in the states of $C_3H_8^+$ which dissociate into C_1 ion fragments, and the states of $i-C_4H_{10}^+$ which dissociate into C_1 or C_2 ion fragments the carbon atoms become essentially indistinguishable. A.

537.564

4485. On the ionization yields of heavy particles. J. K. KNIPP AND R. C. LING. *Phys. Rev.*, **82**, 30-5 (April 1, 1951).

Since the energy loss of a slow heavy particle is due predominantly to recoiling atoms, ionization by secondary heavy particles contributes a large fraction of the total ionization resulting from a slow heavy particle that is stopped in a gas. If the secondary heavy particle ionization efficiency is low, the overall efficiency for the production of ion pairs is greatly reduced for low energies of the primary particle. The secondary heavy particle ionization efficiency satisfies an integro-differential equation in which the ratio of electronic to atomic stopping cross-sections plays a critical role. Data by Madsen on the ionization by recoiling particles in alpha-decay are used to set limits on the ionization by slow A particles in A, from which it is possible to make crude estimates of the energy of fission fragments which fails to give rise to ionization at the usual rate. In A, ionization defects of the order of several MeV are to be expected. A.

537.564

4486. Isotope effect on dissociation probabilities in the mass spectra of chloroform and chloroform-*d*. V. H. DIBELER AND R. B. BERNSTEIN. *J. Chem. Phys.*, **19**, 404 (April, 1951).

The mass spectra of the isotopic molecules $CHCl_3$ and $CDCl_3$ have been determined, using electron energies of 50 V and 70 V. It was found that the probability of dissociation of the C—H bond is

approximately 3 times that for the dissociation of the C—D bond. The relative probability of dissociating $H + Cl$ and $D + Cl$ is the same as the relative probability of obtaining HCl^+ and DCl^+ ions, namely, about 1.6. Equal probability was observed for the dissociation of $H + 2Cl$ and $D + 2Cl$. The probability of removing Cl atoms is only slightly affected by the D substitution. A.

537.581

4487. Measurements of electron emission from the tungsten-carbon and molybdenum-carbon systems. E. BAS-TAYMAZ. *Z. angew. Math. Phys.*, **2** (No. 1) 49-51 (1951) In German.

The Richardson constants were measured in a conventional guard-ring diode. For W_2C , $\phi = 3.85$ eV, $A = 0.35$ A/cm² °K². Carburized Mo showed the following phenomena. The emission followed a Richardson line to 1810°K, at this point the emission jumped by a factor of 10 and followed another line to 1940°K where it returned to the original line. When the temp. was lowered the emission followed the main line down to 1810°K and there jumped to the higher line until 1720°K was reached where it returned to the main line again. The resistance characteristic showed discontinuities at the same temperatures. The effect is reproducible and not caused by contamination. X-ray studies on the phase structure are being made. A. H. W. BECK

537.583

4488. On the electron-optical observation of the emission patterns of barium-azide, barium-oxide and strontium-oxide specks. T. HIBI. *Sci. Rep. Res. Inst. Tôhoku Univ., Ser. A*, **1**, 231-42 (Oct., 1949).

The activation of specks of BaN_3 , BaO and SrO was studied in an emission microscope. A complete description, with many photographs of the observed phenomena is given. It was found that BaO activated much more rapidly than SrO and that a layer of oxide on the core metal delayed activation.

A. H. W. BECK

537.583

4489. Periodic deviations in the Schottky effect for polished tantalum. G. B. FINN, W. B. LAMBERGE AND E. A. COOMES. Letter in *Phys. Rev.*, **81**, 889 (March 1, 1951).

537.583

4490. The barium oxide on tungsten cathode interface. H. P. ROOKSBY AND E. G. STEWARD. Letter in *J. Appl. Phys.*, **22**, 358-9 (March, 1951).

Criticizes the recent report of Hensley and Affleck [Abstr. 407 (1951)] pointing out that tungstates with the crystal structure observed at the interface have been synthesized and that weak lines in the diffraction pattern were missed, causing an incorrect identification as tungstites.

A. H. W. BECK

537.583

4491. The barium oxide on tungsten cathode interface. E. B. HENSLEY AND J. H. AFFLECK. Letter in *J. Appl. Phys.*, **22**, 359 (March, 1951).

Reply to letter reported in preceding Abstr., agreeing that tungstites are not, in fact, formed.

A. H. W. BECK

537.583 : 621.385.032.216

4492. On the equation of thermionic emission of the oxide-coated cathode. Y. WATANABE, E. TAKAGI AND S. KATSURA. *Techn. Rep. Tôhoku Univ.*, **14** (No. 1) 26-45 (1949).

The theory of thermionic emission from an N-type semiconductor is discussed assuming that the impurity level is infinitely narrow and includes some frozen holes (Nijboer). It is shown that, according to the concentration of frozen holes, the emission equation is given by the Richardson, Wilson or Nijboer equations, and that, in general, the Richardson line is expected to exhibit either one or two kinks if observations are made over a large enough range of temperatures. A modified method of measuring the work function using the initial current characteristic is described and applied to well and poorly activated cathodes. For the poorly activated cathode the c.p.d. showed a kink between 800-850°K and a strong temperature dependence while the well activated cathode had a temperature coefficient of 1.2×10^{-4} . The behaviour of these diodes is discussed in the light of the theory developed. For another hypothesis relating to kinks in Richardson plots see Abstr. 5077 (1950).

A. H. W. BECK

COSMIC RAYS 537.591

537.591

4493. On Fermi's theory of the origin of cosmic radiation. C.-Y. FAN. *Phys. Rev.*, **82**, 211-16 (April 15, 1951).

Starting from Fermi's theory of the origin of cosmic radiation, an explanation of the observed shape of the energy spectrum of the proton component is suggested. On this basis there seems to be some indication that the majority of the protons originate from the nucleus of our galaxy. Assuming that the nucleus of the galaxy is a cluster of stars, the origin of the heavier nuclear components and protons of cosmic radiation can be explained on the same basis providing that an ordinary star can eject high energy particles (up to 1 BeV per nucleon). The observation of the effect of the sun on the heavier nuclear components may give a critical test of the theory. The trapping magnetic field, if any, of the galaxy has a negligible effect on the energy spectra of cosmic radiation observed on the earth. The age of the galaxy is estimated to be greater than two billion years.

A.

537.591 : 539.18

4494. Differential multiplicity in meson production. K. SITTE. Letter in *Phys. Rev.*, **81**, 484-5 (Feb. 1, 1951).

By comparing the latitude effect of mesons, and of the primaries at high altitude, values are derived for the number of mesons produced in a given energy range as a function of primary energy.

E. P. GEORGE

537.591 : 539.18

4495. The integral multiplicity of meson production. K. SITTE. Letter in *Phys. Rev.*, **81**, 628-9 (Feb. 15, 1951).

Assuming no latitude effect for protons at atmospheric depth, the number of mesons produced per primary particle is deduced from the height-intensity curves at several latitudes.

E. P. GEORGE

537.591 : 539.18

4496. Temperature of the upper atmosphere and meson production. A. DUPERIER. Letter in *Nature, Lond.*, **167**, 312-13 (Feb. 24, 1951).

A previously reported positive temp. coeff. [Abstr. 346 (1950)] was explained in terms of competition between decay and nuclear absorption of π mesons in the 100/200 mB region. Further measurements confirm the effect, and the analysis has been extended to the 50 mB layers. While the suggested interpretation is in qualitative agreement with observation, there is a numerical discrepancy of at least 3 times. Possible reasons for the discrepancy are discussed.

E. P. GEORGE

537.591 : 778.3

4497. Multiple scattering of fast particles in photographic emulsions. L. VOJVODIC AND E. PICKUP. Letter in *Phys. Rev.*, **81**, 890 (March 1, 1951).

The formulation of Williams's theory by Rossi and Greisen [*Rev. Mod. Phys.*, **13**, 241 (1941); Abstr. 1331 (1942)] predicts greater mean scattering angles than those measured, whereas the detailed theory of Williams [*Proc. Roy. Soc.*, **169**, 531 (1939)] gives results in approximate agreement with experiment.

A. C. COATES

537.591.1

4498. The qualitative similarity of origin of the main cosmic radiation and of showers. J. CLAY. Letter in *Phys. Rev.*, **81**, 645 (Feb. 15, 1951).

Experiments are described which are interpreted as demonstrating a high probability that a meson reaching sea-level will be accompanied by another meson (or its decay electrons) at distances of the order 20 cm.

J. G. WILSON

537.591.1

4499. A search for primary cosmic gamma-radiation. I. G. J. PERLOW AND C. W. KISSINGER. *Phys. Rev.*, **81**, 552-4 (Feb. 15, 1951).

A search has been made for primary cosmic gamma-radiation in the energy range 3.4 to 90 MeV. The apparatus was a counter telescope in which ionizing rays were excluded by anticoincidence and γ -rays detected by their conversion products in Pb. The apparatus was carried above the atmosphere in a V-2 rocket launched at White Sands, New Mexico. The recorded γ -ray counting rate is reduced about a factor of 2 by corrections of various sorts. The variation of detection efficiency with energy permits the results to be stated in terms of the energy crossing unit horizontal area in unit time. The result is 1.4 MeV/cm²/sec. This is 1 300 times less than the corresponding figure for the total cosmic-ray energy at this latitude. Considering the smallness of the result and the nature of the corrections, it is possible that the result is actually a null one.

A.

4500. The neutrons from the nucleonic component as an indicator of changes in primary intensities. J. A. SIMPSON, JR. Letter in *Phys. Rev.*, **81**, 895-6 (March 1, 1951).

The case for using neutrons as indicator rather than μ -mesons is argued. Observations are discussed, illustrating the point.

E. P. GEORGE

537.591.1 : 523.72

On the electromagnetic radiation of cosmic protons in the intense magnetic fields of celestial objects. See Abstr. 4050

537.591.15

4501. On the existence of Rossi second and third maxima. P. K. S. CHAUDHARY. Letter in *Phys. Rev.*, **81**, 274 (Jan. 15, 1951).

537.591.15

4502. Barometric and temperature coefficients of frequency of small cosmic-ray bursts and of burst-corrected cosmic-ray ionization. J. W. BROXON. *Phys. Rev.*, **81**, 555-64 (Feb. 15, 1951).

Barometric and (surface) temperature coefficients are determined for a class of cosmic-ray bursts consisting of 1.2 to 1.9×10^6 ion pairs in A at 20 atm. in a heavily shielded chamber, as well as for the burst-corrected ionization. For the bursts the coefficients (particularly the temperature coefficient) are found to depend upon whether the multiple regression coefficient and partial correlation coefficient are computed from daily averages for individual months or for all 581 days, the latter yielding a positive temperature coefficient of $0.24\%/^{\circ}\text{C}$, in which confidence is somewhat lacking because it depended upon 4 readers. Comparisons are made with earlier observations with the same chamber containing air at 160 atm. and with the observations of other experimenters, and the relations of these to the explanation of the temperature dependence in terms of meson decay developed by Blackett and Duperier are discussed. Values for the mean free paths of the radiations producing the small bursts and the burst-corrected ionization are deduced on the basis of their respective barometric coefficients.

A.

537.591.15

4503. On the density spectrum and structure of extensive air showers. S. F. SINGER. *Phys. Rev.*, **81**, 579-92 (Feb. 15, 1951).

Experiments on the particle density spectrum and structure of extensive air showers were conducted in the Arctic regions by means of a G.M. counter arrangement which allowed simultaneous measurements on showers of high and low densities. The mean densities investigated ranged from about 40 to 1 000 particles/ m^2 . The integral density spectrum of shower particles at sea level was found to be $N(>\rho) = 562\rho^{-1.4}\text{hr}^{-1}$ (ρ in particles/ m^2). With this spectrum it was possible to satisfy all the experimental data obtained with arrangements of various counter areas and multiplicities of coincidences. The decoherence curve of two counters, where extensive showers were first selected by a master coincidence, was found to be flat for small separations down to 7 cm, in disagreement with the results of other workers who did not select extensive showers. This result provides evidence against the existence of a

large number of "cores" distributed throughout the extent of the shower. No latitude dependence of extensive showers was found between geomagnetic latitudes $\lambda = 50^{\circ}$ and $\lambda = 80^{\circ}$ to 90° .

537.591.15

4504. Delays of penetrating particles in atmospheric showers. L. MEZZETTI, E. PANCINI AND G. STOPPINI. Letter in *Phys. Rev.*, **81**, 629-30 (Feb. 15, 1951).

A significant increase in the delays about 2 to 4×10^{-7} sec were detected when one tray of a set of 3 was shielded with Pb.

E. P. GEORGE

537.591.15

4505. Nuclear explosions, and the absorption of "narrow" showers in Pb. J. HAMELIN AND M. SCHERER. *C.R. Acad. Sci., Paris*, **232**, 718-20 (Feb. 19, 1951) In French.

An array of unshielded counters and of counters under a variable Pb shield includes an unshielded tray located from 1.5 m to 2.5 m from the remainder of the apparatus, and attention is directed to events in which this tray is not discharged. The residual incident showers are shown to be absorbed in about 5 cm Pb, while counts corresponding to nuclear explosions (stars) reach a maximum in the same thickness.

J. G. WILSON

537.591.15

4506. Angular and radial distributions of particles in cascade showers. L. EYGES AND S. FERNBACH. *Phys. Rev.*, **82**, 23-9 (April 1, 1951).

The moments of the distribution functions are calculated in a shower neglecting collision loss of electrons, i.e. for energies E much greater than the critical energy ϵ . Expressions are derived for the moments when collision loss is not negligible. These expressions are in the form of a series in ϵ/E , and are valid down to a few times the critical energy. These moments are used to calculate the distribution functions for energies down to a few times the critical energy.

A.

537.591.15

4507. Cosmic-ray bursts and the nucleonic cascade. G. N. WHYTE. *Phys. Rev.*, **82**, 204-8 (April 15, 1951).

The cosmic-ray burst rate has been measured as a function of altitude at geomagnetic latitudes of 0° , 29° and 35°N by means of a thin-walled spherical ionization chamber. The burst rate at an atmospheric depth of 20 g/cm^2 increases by a factor of 6 between 0° and 52° . When the data are corrected for the effects of heavy primary nuclei, the residual rates, believed due almost entirely to nuclear disintegrations, show maxima below the top of the atmosphere. The maxima at 0° , 29° , 35° and 52° occur at depths of approximately 100, 70, 60 and 50 g/cm^2 respectively.

A.

537.591.15 : 539.18

Shower production in Fe by μ -mesons. See Abstr. 4756

537.591.15

4508. The change of cosmic-ray neutron intensity following solar disturbances. J. A. SIMPSON, JR. Letter in *Phys. Rev.*, **81**, 639-40 (Feb. 15, 1951).

Significant increases of neutron intensity at 30 000 ft in high latitudes during a period of severe

solar disturbance (25–31 Oct., 1950), a variation in position of the "knee" of the latitude curve, and the slope of the curve above the "knee" are discussed.

J. G. WILSON

537.591.5

4509. An increase of the primary cosmic-ray intensity following a solar flare. M. A. POMERANTZ. *Phys. Rev.*, **81**, 731–3 (March 1, 1951).

An increase of $15.4 \pm 4.3\%$ has been detected in the intensity of cosmic rays at altitudes between 95 000 and 100 000 ft, occurring approximately 19 hr after the commencement of the outstanding solar flare of May 10, 1949. The observations were conducted with a quadruple-coincidence counter train inclined at a zenith angle of 60° , and containing an interposed absorber of 1 cm of Pb. Complications introduced by atmospheric absorption, possible directional asymmetry, and multiplicative effects preclude a precise evaluation of the increase in terms of absolute primary particle intensity. The effect of the particles emitted by the sun during the chromospheric eruption does not manifest itself at altitudes below approximately 55 000 ft.

A.

537.591.8

4510. Varying nuclear emulsion sensitivity with altitude. A. BEISER. Note in *Rev. Sci. Instrum.*, **21**, 1025–6 (Dec., 1950).

537.591.8

4511. Use of a radio link for observations of coincidences between distant counters. E. PICARD, A. ROGOZINSKI AND M. SURDIN. *C.R. Acad. Sci., Paris*, **232**, 503–5 (Feb. 5, 1951) In French.

537.591.8

4512. Neutron production by cosmic rays at sea level. A. R. TOBEY AND C. G. MONTGOMERY. *Phys. Rev.*, **81**, 517–19 (Feb. 15, 1951).

Neutrons produced by the cosmic radiation at sea level in paraffin, Al and Pb have been measured in a B-filled ionization chamber provided with B guard rings. Proper application of the diffusion theory of slow neutrons was possible and absolute values of the rate of production of neutrons per gram per sec were obtained.

A.

537.591.8

4513. Calculations on the number of neutrons in the atmosphere. S. LATTIMORE. Letter in *Phys. Rev.*, **81**, 643 (Feb. 15, 1951).

The correlation of thermal neutron intensity measurements in the free atmosphere and inside a local mass of condensed material is shown to be better than has usually been supposed, discrepancies having arisen through errors of calculation.

J. G. WILSON

537.591.8

4514. A cloud-chamber study of nuclear interactions in lead and aluminum. I. B. P. GREGORY AND J. H. TINLOT. *Phys. Rev.*, **81**, 667–75 (March 1, 1951).

The nuclear interactions of cosmic-ray particles in Pb and Al have been studied in 2 cloud-chamber experiments. The results of the first experiment, which yields an unbiased sample of interactions of protons, are used to discuss the relative and absolute cross-sections in the two materials and the absolute intensity and energy spectrum of the incident protons.

The second experiment was designed to select interactions of neutrons in which at least one penetrating ionizing particle was produced. The types of interactions observed are in this case intimately related to the probability of triggering the cloud chamber. This problem is discussed in some detail, preparatory to more detailed analysis of this experiment in Part II [Abstr. following].

A.

537.591.8

4515. A cloud-chamber study of nuclear interactions in lead and aluminum. II. B. P. GREGORY AND J. H. TINLOT. *Phys. Rev.*, **81**, 675–82 (March 1, 1951).

The results of the cloud-chamber Experiment B described in preceding Abstr. are used to discuss some properties of the particles produced in nuclear interactions. Evidence is presented showing that the electronic showers produced in nuclear interactions are all photon-initiated. Upper limits on the proportion of directly produced electrons are found to be 20% in interactions in Al and 41% in Pb. The possibility that the photons are decay products of neutral π -mesons is strongly indicated, although no definite proof can be given. It is shown that the mean free paths for nuclear interaction of secondary penetrating particles are 172 ± 30 g/cm² in Pb and 164 ± 50 g/cm² in Al. Assuming that the penetrating particles consist of equal numbers of π -mesons and protons, one obtains an upper limit of 250 g/cm² for the mean free path for interaction of π -mesons in Pb.

A.

537.591.8

4516. Cosmic-ray neutrons. S. A. KORFF. *Amer. J. Phys.*, **19**, 226–9 (April, 1951).

The discovery of neutrons produced by the cosmic radiation is reviewed, and the evidence today available is summarized. The life history of a neutron in the atmosphere is discussed, as is its eventual capture to form radiocarbon. The latitude effect and altitude dependence are presented. Some of the possible production-processes are discussed.

A.

MAGNETISM 538

538.1

4517. The determination of the energy of a ferromagnetic domain boundary. H. KAPLAN. Letter in *Phys. Rev.*, **81**, 885–6 (March 1, 1951).

The effects of the K_2 term in the anisotropy energy and the effects of wall deformation are studied theoretically and found to lead to a correction of $\sim 3\%$.

E. P. WOHLFARTH

538.114

4518. On the conditions of the occurrence of ferromagnetism in metal compounds and in solutions. P. F. VÁRADI. Letter in *Physica*, **16**, 920 (Dec., 1950).

538.12 : 621.318.3

4519. A new type of electromagnet. I. Operation at 20-kW level. F. BITTER AND F. E. REED. *Rev. Sci. Instrum.*, **22**, 171–3 (March, 1951).

An improved iron core magnet for general laboratory use, weighing 2 t, has been designed and several units have been constructed. The design incorporates

the desirable features of a number of earlier magnets and is engineered to give the optimum utility with minimum space and weight and with minimum attention by the operating personnel. A summary of test performance at 20 kW is given.

A.

538.21

4520. Crystalline magnetic anisotropy in zinc manganese ferrite. J. K. GALT, W. A. YAGER, J. P. REMEKA AND F. R. MERRITT. Letter in *Phys. Rev.*, **81**, 470 (Feb. 1, 1951).

The following results were obtained for a single crystal having the composition $\text{Zn}_{0.55}\text{Mn}_{0.45}\text{Fe}_2\text{O}_4$: saturation moment at R.T. = 181 c.g.s.u.; K (from resonance measurements at 24 160 Mc/s) = -3.8×10^3 erg/cm³; ΔH , the width of the resonance line, = 70 oersted; $g = 1.997$.

E. P. WOHLFARTH

538.21

4521. Ferromagnetic resonance in various ferrites. W. A. YAGER, F. R. MERRITT AND C. GUILLAUD. Letter in *Phys. Rev.*, **81**, 477-8 (Feb. 1, 1951).

The g -factors and line widths for polycrystalline Mg, Ni, Co, Mn and Mn-Zn ferrites were measured at R.T. at a frequency 24 164 Mc/s. The dependence of g and ΔH on the specimen size is discussed and values extrapolated to zero size are given.

E. P. WOHLFARTH

538.214

4522. On the change of reversible susceptibility of ferromagnetic substances due to tension. T. KATAYAMA AND N. KUNITOMI. *Sci. Rep. Res. Inst. Tôhoku Univ., Ser. A*, **2**, 22-8 (Feb., 1950).

According to the internal stress theory on ferromagnetic substances given by Kersten and Döring, the authors have calculated the reversible susceptibility as a function of magnetization under various applied tensions. Theoretical reversible susceptibility thus obtained is constant at early stage of magnetization and decreases rapidly just before the magnetic saturation. But, if the magnitude of internal stress is larger than that applied, it has a maximum before sudden decrease, which occurs near magnetic saturation. These theoretical results explain experimental data qualitatively, but some quantitative differences are found between these.

A.

538.22 : 532.73

Nuclear spin relaxation in dilute Na/liquid-NH₃ solutions. See Abstr. 4156

538.221

4523. Cation arrangement of magnetite at low temperatures. H. WATANABE. *Sci. Rep. Res. Inst. Tôhoku Univ., Ser. A*, **2**, 280-8 (April, 1950).

Magnetic behaviour of magnetite at low temperatures is considered on the basis of Verwey's assumption of cation arrangement. This concept is applied to the interpretation of magnetic hardness and field cooling phenomena observed by Domenicali.

538.221

4524. Measurement of the gyromagnetic constant of ferromagnetic elements and of some isoelectronic alloys of the Fe group. A. J. P. MEYER. *Ann. Phys., Paris*, **6**, 171-210 (Jan.-Feb., 1951) In French.

The resonance method of Einstein-de Haas has been used to confirm the Landé factor for Fe and

Ni as 2.00. The same result is also obtained for FeNi, (FeNi)-Co, with 73.5% Co, FeCo and Fe₃Ni. Earlier work is reviewed, the theory of the method and the experimental technique are described in detail, and the implications of the results are briefly considered.

G. F. HODSMAN

538.221 : 530.145.6

4525. On the theory of spin waves in ferromagnetic media. C. HERRING AND C. KITTEL. *Phys. Rev.*, **81**, 869-80 (March, 1951).

The theory of spin waves, leading to the Bloch $T^{\frac{3}{2}}$ law for the temperature variation of saturation magnetization, is discussed for ferromagnetic insulators and metals, with emphasis on its relation to the theory of the energy of the Bloch interdomain wall. The analysis indicates that spin-wave theory is of more general validity than the Heitler-London-Heisenberg model from which it was originally derived. Many properties of spin waves of long wavelength can be derived without specialized assumptions, by a field-theoretical treatment of the ferromagnetic material as a continuous medium in which the densities of the three components of spin are regarded as amplitudes of a quantized vector field. As applications, the effects of anisotropy energy and magnetic forces are calculated; and it is shown that the Holstein-Primakoff result for the field dependence of the saturation magnetization can be derived in an elementary manner. An examination of the conditions for validity of the field theory indicates that it should be valid for insulators, and probably also for metals, independently of any simplifying assumptions. The connection with the itinerant electron model of a metal is discussed; it appears that this model is incomplete in that it omits certain spin wave states which can be proved to exist, and that when these are included, it will yield both a magnetization reversal proportional to $T^{\frac{3}{2}}$ and a specific heat proportional to T . Incidental results include some insight into the relation between the exchange and Ising models for a two-dimensional lattice, an upper limit to the effective exchange integral, and a treatment of spin waves in rhombic lattices.

A.

538.221 : 536.631 : 538.632

4526. Research on the specific heat and the Hall effect of magnetite. T. OKAMURA AND Y. TORIZUKA. *Sci. Rep. Res. Inst. Tôhoku Univ., Ser. A*, **2**, 352-60 (April, 1950).

These have been measured for both artificial and natural magnetite at various low temperatures by means of Sykes's method. The specific heats of various heat-treated magnetites were measured and it has been confirmed experimentally that the peak appearing on the curves of specific heat v . temperature changes by heat treatment, if the specimen is heated above 1 000°. From the measurement of Hall effect, it has been found that the electric current in magnetite is contributed to only the conduction electron on impurity level. Intensity of magnetization abruptly decreases at the transformation temperature.

A.

538.221 : 539.217

4527. Precipitation and the domain structure of alnico 5. A. H. GEISLER. Letter in *Phys. Rev.*, **81**, 478-9 (Feb. 1, 1951).

538.221 : 539.23

4528. Thin ferromagnetic films. M. J. KLEIN AND R. S. SMITH. *Phys. Rev.*, **81**, 378–80 (Feb. 1, 1951).

The magnetic properties of thin films of ferromagnetic materials have been studied by means of the Bloch spin-wave theory. The spontaneous magnetization depends upon the number of atomic layers, G_z , in the film. For thicknesses below a "critical" thickness, which depends on the temperature and film dimensions, the spontaneous magnetization decreases rapidly as the number of atomic layers is decreased. The temperature dependence of the spontaneous magnetization varies from a $T^{\frac{3}{2}}$ law for very thick films to a linear function of T for a monolayer film. The spontaneous magnetization, at fixed temperature and film thickness, decreases as the film dimension increases. A.

538.221 : 539.26

4529. Changes of crystal structure in antiferromagnetic compounds. H. P. ROOKSBY AND N. C. TOMBS. Letter in *Nature, Lond.*, **167**, 364 (March 3, 1951).

A continuation of the work by Greenwald and Smart [Abstr. 492 (1951)] to MnS, indicating a deformation of the crystal structure on cooling through the antiferromagnetic Curie point. Work on FeO is also reported; it is found that the magnitude of the rhombohedral deformation is related to the deficiency in Fe in non-stoichiometric samples.

E. P. WOHLFARTH

538.222

4530. Paramagnetic resonance absorption in potassium dissolved in liquid ammonia. C. A. HUTCHISON, JR AND R. C. PASTOR. Letter in *Phys. Rev.*, **81**, 282 (Jan. 15, 1951).

538.222

4531. Paramagnetic resonance at very low fields. M. A. GARSTENS. Letter in *Phys. Rev.*, **81**, 645 (Feb. 15, 1951).

A strong and narrow paramagnetic resonance absorption line was observed at fields from 7 to 10.3 gauss in a one-gram sample of the free radical $(C_6H_5)_2N-NC_6H_4(NO_2)_2$.

L. PINCHERLE

538.222

4532. Paramagnetic resonance in metal ammonia solutions at very low fields. M. A. GARSTENS AND A. H. RYAN. Letter in *Phys. Rev.*, **81**, 888 (March 1, 1951).

538.222 : 539.152.1

4533. Nuclear spin of erbium-167. B. BLEANEY AND H. E. D. SCOVIL. Letter in *Proc. Phys. Soc., Lond. A*, **64**, 204–5 (Feb., 1951).

The paramagnetic resonance spectrum of erbium ethyl sulphate at 1.2 cm consists of a central line with eight equally spaced satellites which are assigned to Er^{167} with a nuclear spin $7/2$. $g_{||}$ to axis = 1.47, $g_{\perp}$ = 8.85 and ΔH varies as $1/g$. τ due to spin-lattice relaxation is 0.95×10^{-9} sec at 13°K and $\frac{1}{T_0}$ of this value at 20°K. The Ce, Sm, Dy and Yb ethyl sulphates show no absorption. D. H. WHIFFEN

538.222 : 539.152.1

4534. A preliminary survey of the paramagnetic resonance phenomena observed in rare earth ethyl

sulphates. R. J. ELLIOTT AND K. W. H. STEVENS. Letter in *Proc. Phys. Soc., Lond. A*, **64**, 205–7 (Feb., 1951).

A first-order treatment of the ions in a crystal field of symmetry D_{3h} gives agreement with the observed paramagnetic resonance for Nd^{+++} and Er^{+++} , and indicates the absence of absorption for Ce^{+++} , Sm^{+++} , Dy^{+++} and Yb^{+++} , in the range of observation. The hyperfine structure is briefly discussed. D. H. WHIFFEN

538.222 : 541.67

4535. Magnetochemistry of the heaviest elements. III. The halides of ter- and quadri-valent uranium. J. K. DAWSON. *J. Chem. Soc.*, 429–31 (Feb., 1951).

See Abstr. 8868 (1950) for Part II. UF_4 , UCl_4 and UBr_4 obey the Weiss–Curie law over the temperature range 77–550°K. The values obtained for the magnetic moment of the quadrivalent U ion indicate that in these compounds the ion has a $5f^2$ electron configuration. UCl_3 , UBr_3 and UI_3 deviate from the Weiss–Curie law below about 350°K and are anti-ferromagnetic; the results are interpreted as arising from a $5f^2.6d^1$ electron configuration for the tribromide and tri-iodide, but the electron assignment is not conclusive for the trichloride. A.

538.24

4536. Magnetic domain patterns on nickel crystals. M. YAMAMOTO AND T. IWATA. Letter in *Phys. Rev.*, **81**, 887–8 (March 1, 1951).

Powder patterns were obtained on the (110) surface of a nickel crystal demagnetized by an alternating field parallel to the [110] direction (with or without a weak field normal to the surface) and the [001] direction. E. P. WOHLFARTH

538.24 : 621.318.1.013

4537. Investigation of non-reversible sudden changes of magnetization. B. F. TSOMAKION AND V. F. IVLEV. *Dokl. Akad. Nauk, USSR*, **76** (No. 2) 205–8 (1951) In Russian.

The phenomenon of sudden discontinuous changes of magnetism in a ferromagnetic object when the intensity of the applied magnetic field is varied slowly and continuously ("Barkhausen" effect) is investigated experimentally, a new method being described, capable of higher sensitivity than heretofore. The results establish the average volume of the nickel domain to be 1.37×10^{-9} cm³, and the instrument is able to differentiate between domains separated by $< 0.5 \times 10^{-9}$ cm³. It consists essentially of a single-stroke pulse generator (thyatron) used as a comparator and alternatively with the search coil (which is placed around the investigated object and itself within a magnetizing coil), switched to an amplifier and connected either to a mirror galvanometer or a recording oscillograph. A. LANDMAN (R)

538.245 : 621.318.2/3 : 621.317.44

4538. An automatic magnetic balance for the study of ferromagnetic materials. R. F. S. ROBERTSON AND P. W. SELWOOD. *Rev. Sci. Instrum.*, **22**, 146–52 (March, 1951).

An instrument is described for plotting, automatically, magnetization-temperature curves for ferromagnetic substances. The sample is placed on a

torsion arm in an inhomogenous magnetic field, and the force to which it is subjected is opposed by a torque applied to a torsion wire by a reversible motor. The shaft of the motor is connected to a Beckmann Helipot, and the motion of the shaft is converted into a change in e.m.f. which is recorded by a Leeds and Northrup Speedomax. The temperature of the sample is also controlled and recorded by the Speedomax. Data on the performance of the instrument are given and sample plots of thermomagnetic runs for Ni, Fe_3O_4 and Fe_3C are shown. A.

ELECTROMAGNETISM . ELECTRODYNAMICS

538.3/5

538.3 : 530.12 : 621.3.011

4539. Derivation of the phenomenon of electromagnetic induction from the theory of relativity. E. KÜBLER. *Elektrotech. u. Maschinenb. [EuM]* **68**, 68–73 (Feb. 15, 1951) In German.

The special theory of relativity is based on the observation of the velocity of light being independent of any constant velocity motion of the system from which the propagation of light waves is observed. It leads to consequent variations of space and time as functions of the velocity of the reference system. This is used to derive the voltage induced in a conductor moving through the magnetic field in the space between parallel conductors carrying current in opposite directions. Maxwell's representation of a constant current by two streams of equal positive and negative charges moving in opposite directions with the velocity of light can be reconciled with the invariance of this velocity by the introduction of the charge density becoming different with reference to the moving conductor. This leads to residual charges which generate an electric field found to be the same as that derived from the law of electromagnetic induction. A similar consideration explains the voltages induced by the rate of change of current from the charge density of the oppositely progressing partial waves varying in space and time and thereby preventing local cancellation of the positive and negative charges moving in opposite directions. The presence of a magnetic field is concluded only from considerations of energy relations.

E. FRIEDLANDER (R)

538.3

4540. The classical motion of a rigid charged body in a magnetic field. H. GOLDSTEIN. *Amer. J. Phys.*, **19**, 100–9 (Feb., 1951).

A frequently used classical analogue to the quantum precession of a magnetic moment in a magnetic field is the motion in a uniform static magnetic field of a symmetrical rigid body charged so that the ratio of charge to mass density is uniform. In general, the figure axis of such a magnetic top both precesses and nutates, and the mechanism producing the nutation is qualitatively different from that responsible for the nutation of the familiar gravitational top. Unless the body is spherical the angular momentum vector also nutates in the course of the precession, a pheno-

menon caused by the deviation of the torque on the body from the customary, but here incorrect, expression $\mathbf{M} \times \mathbf{B}$. The uniform precession frequency of the magnetic top is not the Larmor frequency but involves in addition terms depending on higher powers of the magnetic field, a correction which corresponds to the quadratic Zeeman effect. A.

538.3 : 538.566 : 621.3.011

4541. Separation of variables in electromagnetic theory. D. E. SPENCER. *J. Appl. Phys.*, **22**, 386–9 (April, 1951).

Separability conditions are obtained for the partial differential equations of electromagnetic theory. Waveguide and aerial problems are expressed in terms of the vector Helmholtz equation, and solutions are indicated by use of the simple method of separation of variables without recourse to Green's functions. It is shown that complete separation occurs only in rectangular co-ordinates, but that separation of the equation for one component of the vector field occurs in two co-ordinate systems. With cylindrical or rotational symmetry, separation is possible in 8 co-ordinate systems. A.

ELECTROMAGNETIC WAVES AND

OSCILLATORS 538.56

538.59

4542. The mathematical theory of electromagnetic oscillations. C. MÜLLER. *Abh. Dtsch. Akad. Wiss. Berlin, Math.-nat. Kl. (No. 3)* 55 pp. (1945–46).

A lucid derivation and discussion of formulae for calculating the electromagnetic field in a homogeneous medium from known surface values and internal currents (all simply harmonic in time); and of formulae for calculating the field in an insulating dielectric from known currents in an infinite surrounding medium. P. M. DAVIDSON

538.561

4543. Analysis of an R-C oscillator. J. H. HOWEY. *Amer. J. Phys.*, **19**, 85–6 (Feb., 1951).

The equations for an RC oscillator are derived completely from fundamental relationships without the use of alternating current concepts and without the use of complex numbers. Analysed in this way, the RC oscillator constitutes a good subject for an experiment dealing with the equation for simple harmonic motion. Theoretical expressions obtained for the frequency and for the damping coefficient can be verified by experiment, and either positive or negative damping may be had. With commonly available apparatus, the period may be made several seconds long. The oscillations and the growth or decay of amplitude with time can thus be observed directly with a milliammeter biased to read zero at its centre. A.

538.566 : 621.3.011 : 621.392.2

4544. Propagation on dielectric coated wires. E. T. KORNHAUSER. Letter in *J. Appl. Phys.*, **22**, 525 (April, 1951).

538.566 : 621.396.11

4545. Surface-wave propagation over a coated plane conductor. S. S. ATTWOOD. *J. Appl. Phys.*, **22**, 504-9 (April, 1951).

A *TM*-type wave is assumed to be propagated parallel to the surface of a plane conductor coated with a thin layer of dielectric. Analysis of the wave over a plane surface may be described by trigonometric functions in the dielectric layer and real exponential functions in the adjacent air region. Basic equations are developed for both dielectric layer and air regions, which indicate a criss-cross or multiply reflected wave in the dielectric and a uni-directional wave in the air. Equations are developed also for the electric flux line shapes, power propagated over the cross-section, concentration of power flow in neighbourhood of the film, attenuation due to conductor wall loss and dielectric film loss. Numerical calculations are given for 5 film thicknesses in the range $0.0001-0.01$ m and for 5 frequencies in the range 3×10^8 to 3×10^{10} c/s. A.

538.566

4546. Microwave reflection from water spheres. A. L. ADEN. *Amer. J. Phys.*, **19**, 163-7 (March, 1951).

When any material object is placed in the field of an electromagnetic wave, the object removes energy from the field. In general, some of the energy is dissipated internally as heat, and some of the energy is reradiated to produce a secondary or scattered field. The back-scattering cross-section is a lumped measure of the ability of the scattering object to reradiate energy in the direction of the source. This paper deals with the experimental determination of the back-scattering cross-section for water spheres with sizes comparable with the wavelength. The determination of this parameter is fundamental in the investigation of the microwave reflection from rain. A.

538.566 : 535.421

4547. Erratum: Diffraction pattern in a circular aperture measured in the microwave region. C. L. ANDREWS. *J. Appl. Phys.*, **22**, 520 (April, 1951).

See Abstr. 7383 (1950).

538.566 : 621.3.013.78

4548. Theory of electro-magnetic shielding by shielding room of wire-netting. T. MATSUMOTO. *Monogr. ser., Res. Inst. Appl. Elect., Japan*, No. 1, 55-68 (1950).

When the radiating source is a current loop the screening effect reaches a max. at a characteristic frequency $f_c = 3 \times 10^8 / 2\pi r_0$, where r_0 is the radius of the screened room. This effect is a function of the material and diameter of the wire of the protective screen. For frequencies $> f_c$ the size of the wire is essential, while for frequencies $< f_c$ the material is a characteristic. The screening effect is inversely $\propto$ the mesh-size of the screen. When the source is an electric dipole or a capacitor there is no peak frequency and the screening effect is inversely $\propto$ the frequency. W. SUMMER

538.566 : 621.396.671

4549. Diffraction pattern of microwaves near rods. C. L. ANDREWS. *J. Appl. Phys.*, **22**, 465-8 (April, 1951).

The diffraction patterns of electromagnetic waves in the neighbourhood of rods a $\lambda/2$ long have been calculated from rigorous electromagnetic theory and checked with 8 cm microwaves. This was the one case in which the patterns could be calculated at short distances from the diffracting objects without difficulty. The agreement of measurements and exact theory suggested that microwave measurements within a few wavelengths of diffracting objects will be a fruitful approach to diffraction problems. A.

538.566 : 621.396.671.088

4550. Diffraction errors in an optical measurement at radio wavelengths. G. A. WOONTON, J. A. CARRUTHERS, H. A. ELLIOTT AND E. C. RIGBY. *J. Appl. Phys.*, **22**, 390-7 (April, 1951).

The errors arising in the measurement of aerial patterns by means of a lens are examined. The effect of the lens aperture is separated from the effect of lens aberrations and only the effect of the aperture is discussed. Theoretical solution of the problem is obtained for a uniformly illuminated aperture and for short electromagnetic horns. The theory agrees with experimental measurements. Mutilation due to the aperture is examined with the help of both computed results and experimental measurements. The systematic errors due to mutilation have been found and have been shown as precision limits. An extrapolation of the data suggests that a lens 40λ wide can be used for the precision measurement of the patterns of aerials $10-20 \lambda$ wide. The technique is entering its range of usefulness at a wavelength of 3.2 cm and should increase in value as the wavelength is decreased. A.

538.566 : 519.3

4551. Application of the calculus of variations to the problem $\nabla^2 u + \lambda u = 0$. E. KORNHAUSER AND I. STAKGOLD. *C.R. Acad. Sci., Paris*, **232**, 390-1 (Jan. 29, 1951) In French.

A plane region is considered, bounded by a closed curve B . Let λ_n be the eigenvalues for the condition $u(B) = 0$, and μ_n for $du/dn(B) = 0$. It is proved that $\mu_1 < \lambda_0$. Hence the fundamental mode in a waveguide of constant section is always an *H*-wave. L. PINCHERLE

538.566 : 621.385.1.029.6

4552. Amplification of the traveling wave tube. B. FRIEDMAN. *J. Appl. Phys.*, **22**, 443-7 (April, 1951).

A method is presented for solving the equation which determines the modes of a helix with an electron beam [Chu and Jackson, *Proc. Inst. Radio Engrs*, **36**, 853 (1948)]. The modes are considered as a perturbation of those produced by the cold helix. From the solution of the equation, the dependence of the amplification factor of the tube upon the geometrical parameters and the operating conditions is explicitly determined. The solution shows also that the tube will not amplify for too large values of the d.c. electron beam current. A.

538.566 : 621.385.833 : 621.385.1.029.6
4553. Effect of hydrostatic pressure in an electron beam on the operation of traveling-wave devices. P. PARZEN AND L. GOLDSTEIN. *J. Appl. Phys.*, **22**, 398–401 (April, 1951).

Small velocity spreads in an electron beam appear to cause a decrease in gain and noise figure of a travelling-wave tube. The actual decrease depends on a quantity μ , which can be interpreted physically as a measure of the ratio of the coupling of the electrons to each other via the hydrostatic pressure to the coupling of the electrons to the external waveguide circuit. Thus, physically, the effect of the velocity spread is to introduce further interactions among the electrons, in which the external circuit does not take part. This interaction may be thought of as a hydrostatic pressure similar to that in a liquid or gas. A.

538.566 : 621.392.26
4554. The electromagnetic field produced by a helix. R. S. PHILLIPS. *Quart. Appl. Math.*, **8**, 229–46 (Oct., 1950).

Helical waveguides have important applications in u.h.f. amplifiers, hence a mathematically exact investigation of their properties is desirable. The field is calculated of an infinitely thin perfectly conducting helix, excited monochromatically. It is assumed that a sinusoidal distribution of electric current travels along the helix with a real propagation constant in the axial direction. An expression is obtained for the retarded vector potential as an infinite integral, and a detailed examination is made of its properties. It is also evaluated in terms of Bessel functions. Explicit expressions for the electric field are given and the propagation constant is determined from the appropriate boundary conditions along the helix. The radial energy flow is shown to be infinitesimal compared with the axial flow. The restricted application of these results to real helical wires is discussed. A. T. PRICE

538.566.2
4555. On reflection in inhomogeneous media. K. FÖRSTERLING AND H.-O. WÜSTER. *Ann. Phys., Lpz.*, **8** (No. 3–4) 129–33 (1950) *In German*.

Reflection coefficients are calculated for an inhomogeneous medium in which the dielectric constants can be represented as the power of a co-ordinate. Solutions are given which are applicable to the case of the ionosphere. S. TOLANSKY

538.566.2 : 621.396.671
4556. The effect of a grounded slab on the radiation from a line source. C. T. TAL. *J. Appl. Phys.*, **22**, 405–14 (April, 1951).

A theoretical investigation, based upon the method of Fourier transforms, is made of the effect of a grounded dielectric slab on the radiation from a line source. It is shown that the principal part of the electric field above the dielectric slab can be found either by evaluating the resultant contour integral, using the saddle-point method of integration, or by evaluating the integral containing the tangential H -field along the interface. The radiation pattern of the principal field is found to be identical with the

resultant field of a direct ray and a reflected ray that can be obtained by simple geometrical optics. When the slab is thick enough to support a propagating mode, in addition to the space wave, a surface wave will appear in the neighbourhood of the interface. The latter attenuates rapidly as the point of observation is moved away from the interface. The deformation of the path of integration corresponding to different angles of observation has been displayed graphically both in the original h -plane and the transformed τ -plane. A.

538.566.2 : 621.317.335.3
4557. A phase-shift refractometer. C. W. TOLBERT AND A. W. STRAITON. *Rev. Sci. Instrum.*, **22**, 162–5 (March, 1951).

Describes a refractometer for measuring small changes in the dielectric constant or index of refraction of atmospheric air. The method employed is that of measuring the change in phase of a 9 375 Mc/s radio wave along a path ~ 3 ft long caused by a change in the average dielectric constant of the air over the path. The test path may be confined to a waveguide through which air is drawn, or it may be the space between two aerial systems. Because of the greater rigidity and the elimination of reflections, the waveguide system is able to measure short time changes in the index of refraction with an error of < 1 p.p.m. The aerial arrangement usually has somewhat larger error because of the flexibility of the supports and the external reflections. A.

538.566.3 : 621.396.11
4558. Self-interaction of radio waves in the ionosphere. M. CUTOLO. Letter in *Nature, Lond.*, **167**, 314–15 (Feb. 24, 1951).

An account of experiments on the variation in percentage modulation of a received signal as the carrier frequency approaches the gyro-frequency. For a variable frequency transmitter 80% modulated at 230 c/s, the percentage modulation of the received signal decreased to a minimum value of about 40% at the gyro-frequency. The magnitude of the reduction decreases with increasing modulation frequency. See also Abstr. 8890 (1950). W. J. G. BEYNON

538.566.3 : 621.396.11
4559. The ionospheric propagation of low- and very-low-frequency radio waves over distances less than 1 000 km. R. N. BRACEWELL, G. BUDDEN, J. A. RATCLIFFE, T. W. STRAKER AND K. WEEKES. *Proc. Instn Elect. Engrs, Pt II*, **98**, 221–36 (May, 1951) [Reprint No. 1123].

The paper summarizes the results of the various experiments, which are described in detail in separate papers, some of which are to be published later. The results of various independent methods of measuring the apparent height of reflection of the waves show that waves of 16–30 kc/s are reflected as if from a sharply bounded horizontal surface situated at a height of (72 ± 3) km when the sun is overhead. The apparent height of reflection varies regularly with the angle of the sun and its variation may be summarized by an equation. The waves of frequency 30–150 kc/s appear to be reflected from a height of about 75 km at oblique incidence, but there is some evidence that they may be reflected from

10 km higher at vertical incidence. The polarization of the waves at all frequencies is found to be approximately circular at steep incidence, but at oblique incidence (65°) waves of a frequency of 16 kc/s are linearly polarized. No measurements of polarization at oblique incidence have been made on the higher frequencies. The absorption of the waves changes very rapidly with frequency—on a summer day the conversion coefficient varies from about 0.15 at 16 kc/s to 0.002 at 70 kc/s. Important differences in behaviour near sunrise are observed on all frequencies at steep incidence and oblique incidence. The effects of a sudden ionospheric disturbance on the reflected waves are discussed and interpreted as implying a decrease in the apparent height of reflection; the amplitude of the reflected wave is scarcely altered on 16 kc/s, but is much decreased on higher frequencies. A.

538.566.3 : 621.396.11

4560. The effect of the earth's magnetic field on short-wave communication by the ionosphere. G. MILLINGTON. *Instn Elect. Engrs Monogr. No. 1*, 14 pp. (April 16, 1951) [To be published in *Proc. Instn Elect. Engrs, Pt IV*, 98 (1951)].

The magneto-ionic theory for oblique transmission through the ionosphere is considered with special reference to numerical applications, in particular to planning s.w. long-distance communication. The quartic equation of the theory is solved graphically by the intersection of a straight line with a certain curve, and a chart is described for the construction of the latter for various values of the electronic density. By the method of stationary phase, simple expressions are obtained for the differential coefficients of the ray path, including the group time, lateral deviation and specific attenuation. Numerical integration along the ray path for a given density distribution is discussed with special reference to the relation of oblique to vertical transmission. A.

MAGNETIC EFFECTS 538.6

538.613

4561. Magneto-optic effects in glass. I. Some preliminary observations on the application of magneto-optic properties to structural considerations. H. COLE. *J. Soc. Glass Techn.*, 34, 220–37 (Oct., 1950).

Measurements of the Verdet constants for a number of optical glasses have been made, and it is shown that the plot of Verdet constant against reciprocal dispersion for all glasses, and for certain liquids and crystals, yields a smooth curve. Deviations from the simple Becquerel relationship have been calculated, and the value of the magneto-optic anomaly thus obtained has been correlated with the nature of the chemical bonds present in crystals and glasses. On this basis it is deduced that, particularly in dense barium crown glasses, Ba can participate in the glass-network structure to a greater extent than has hitherto been assumed. Similarly, La and Th in glass appear to have appreciable covalent bond character and to behave as network-forming atoms. A.

538.63

4562. The change of the electric resistance of bismuth crystals in strong magnetic fields. I. The method and apparatus for observing the change of resistance of bismuth in strong magnetic fields. Y. TANABE. *Sci. Rep. Res. Inst. Tôhoku Univ., Ser. A*, 1, 267–74 (Oct., 1949).

Apparatus for obtaining intense fields of short duration similar to Kapitza's is described. With suitable coils fields up to 2×10^5 oersted were obtained. The method used for measuring resistance changes in Bi crystals is indicated. E. P. WOHLFARTH

538.63

4563. The change of the electric resistance of bismuth crystals in strong magnetic fields. II. Experimental results. The change of resistance of bismuth crystals in a magnetic field with the current perpendicular to the field. Y. TANABE. *Sci. Rep. Res. Inst. Tôhoku Univ., Ser. A*, 1, 275–82 (Oct., 1949).

Using the apparatus described in preceding Abstr., the change of resistance was measured as a function of H and the orientation of the axis of the crystal with respect to the field direction. For fields up to $\sim 5 \times 10^4$ oersted $\Delta R \propto H^2$, for higher fields $\Delta R \propto H$. E. P. WOHLFARTH

538.632

4564. A new method for the measurement of Hall coefficients. B. R. RUSSELL AND C. WAHLIG. Note in *Rev. Sci. Instrum.*, 21, 1028–9 (Dec., 1951).

538.639 : 548.0

4565. On the electromagnetic properties of single crystals of tellurium. II. Ettingshausen–Nernst effect. T. FUKUROI, S. TANUMA AND S. TOBISAWA. *Sci. Rep. Res. Inst. Tôhoku Univ., Ser. A*, 2, 233–8 (April, 1950).

See Abstr. 3526 (1951) for Part I. The Ettingshausen–Nernst effect of a single crystal of highly purified Te has been measured over the temperatures ranging from -160 to $+300^\circ\text{C}$. In the intrinsic semiconductor range of temperature, it was found that the value of coefficient of this effect is roughly in agreement with that evaluated theoretically from the values of the electron and hole mobilities and the width of the forbidden region, which were deduced by analysing the experimental values of the conductivity, the Hall coefficient and the magneto-resistance coefficient measured on the same specimen. A.

538.639 : 548.0

4566. On the electromagnetic properties of single crystals of tellurium. III. Adiabatic and isothermal Hall effect, and Ettingshausen effect. T. FUKUROI, S. TANUMA AND S. TOBISAWA. *Sci. Rep. Res. Inst. Tôhoku Univ., Ser. A*, 2, 238–48 (April, 1950).

A study has been made of the comparison of the adiabatic and the isothermal Hall effects of a tellurium crystal from -180 to $+350^\circ\text{C}$. An ordinary d.c. method was used for the adiabatic effect and a potentiometric null-method utilizing 1000 c/s a.c. was employed for the isothermal one. The difference of two kinds of Hall coefficients was found to be less than 10% below 230°C , but above 240°C the adiabatic

coefficient has a value as low as 85 ~ 50% of the isothermal coefficient. This notwithstanding, the remarkable sign reversal is observed at 240°C also in the isothermal Hall coefficient, which fact evinces itself to be one of the essential properties of Te. A.

538.65 : 539.37

Magneto-elastic relaxation in Ni. See Abstr. 4794

538.652

4567. Magnetostrictive vibration of prolate spheroids. Preliminary measurements. J. S. KOUVELITES AND L. W. MCKEEHAN. *Rev. Sci. Instrum.*, **22**, 108-11 (Feb., 1951).

Small but accurately shaped prolate spheroids of ferromagnetic substances, almost uniformly magnetized by direct current in a large coaxial solenoid, are subjected to alternating axial applied magnetic fields produced by h.f. current in a smaller coaxial solenoid. Measurements of the impedance of this h.f. coil with a specially designed Maxwell bridge, give, as the driving frequency is varied through the frequency of mechanical resonance in the fundamental mode of longitudinal vibration of the centre-supported spheroid, precise data for analysing the distribution of electromagnetic driving forces and of magnetic, electrical and mechanical losses by a theory to be given elsewhere. Since the spheroid dimensions are about 10 mm for length and 1 mm for dia., the resonant frequencies of interest are near 300 kc/s. Optical measurements of vibration amplitude, possible in principle, have not yet been effected. A.

538.652 : 534.231.3 : 621.396.616

4568. Electromechanical analogies applied to magnetostrictive systems. H. NØDVEDT. *Forsvarets ForsknInst. Arb.*, **2**, 73-94 (1948-49).

See Abstr. 3358 (1949). Directivity requirements of echo sounding apparatus are discussed and the dimensioning of the transducer and choice of frequency are explained. The practical design of a transducer using permanent magnets for providing the polarizing field is described in detail, and illustrations and performance diagrams are given.

J. A. WILCKEN (R)

MOLECULAR AND ATOMIC STRUCTURE 539.1

THEORY OF SOLID STATE 539.11

539.11

4569. On the theory of surface states. H. STATZ. *Z. Naturforsch.*, **5a**, 534-43 (Oct., 1950) In German.

The wave equation for a one-dimensional crystal lattice is used to deduce the conditions for surface electronic states once the boundary of the crystal is reached. Both sinusoidal and square-wave variations of potential along the crystal are considered. The treatment is extended to lattices of more than one dimension. C. A. HOGARTH

539.11

4570. Internal motion of hydrogen absorbed in tantalum. M. A. GARSTENS. Letter in *Phys. Rev.*, **81**, 288 (Jan. 15, 1951).

The width of the nuclear magnetic resonance absorption line was measured at different temperatures with a sample of Ta containing 53.5 at. % of H. This was small at temperatures above 215°K and widened appreciably below this. This is held to indicate that protons are relatively free in Ta at room temperature, at variance with the common assumption that "good" absorbers contain lattice-bound protons. J. R. MADDOX

539.11 : 533.75

4571. The lattice energy of ice and the second virial coefficient of water vapour. J. S. ROWLINSON. *Trans Faraday Soc.*, **47**, 120-9 (Feb., 1951).

An expression is calculated for the latter by taking account of the dipole, quadrupole and non-polar forces. Values of the intermolecular force constants are derived which are used to calculate the lattice energy and intermolecular spacing of ice at 0°K. The values found, 11.10 kcal/mole and 2.73-2.74Å, compare well with the experimental results, 11.32 kcal/mole and 2.72Å. The energy of the O-H...O hydrogen bond is estimated at 4.86 kcal/mole and the coefficient of the dispersive forces at 5.7×10^{-59} erg. cm.⁶ A.

539.11 : 536.63

4572. Note on frequency spectra of simple solids from specific heat data. E. KATZ. *J. Chem. Phys.*, **19**, 488 (April, 1951).

Experimental specific heats determine accurately the low frequency part of the frequency spectrum but allow a latitude, wide enough to fit almost any theory, for its high frequency part. In a Debye plot (effective Debye temperature $\theta \propto v \cdot T$) peaks and dips in the region $0 < T < \theta/10$ represent dips and peaks in the low frequency part of the frequency spectrum. The correspondence is so simple that it can be interpreted at a glance. The peaks and dips are superimposed on a simple Debye spectrum and presumably have a direct physical meaning, in terms of lattice irregularities. Only their centres and total weights are obtainable, so that they act effectively as single Einstein frequencies. In the region $\theta/5 < T < \infty$ all information obtainable about $f(\nu)$ consists of the first few even moments (3 for specific heat errors of order 1%, 5 for 0.1%). These can be represented respectively by two or three weighted equivalent Einstein functions without direct physical meaning. The region $\theta/10 < T < \theta/5$ corresponds to the high frequency part of the frequency spectrum, but hardly any information can be derived here. A.

539.11 : 539.31

4573. Erratum: On the pressure-volume and pressure-compressibility relation of metals. P. GOMBÁS. Letter in *Phys. Rev.*, **82**, 287 (April 15, 1951).

See Abstr. 1016 (1948).

539.11 : 548.7

4574. Interpretation of the vibration spectrum of mix-crystals. F. MATOSSI. *J. Chem. Phys.*, **19**, 161-3 (Feb., 1951).

The vibration frequencies of a linear chain of the

type ...XZYZXZYZ... are calculated and discussed. The chain is considered to be a model for a mix-crystal of the components XZ and YZ. Only one vibration is strongly active enough to give a reflection band, its frequency being intermediate between those of the components, in agreement with observation. Another vibration, at lower frequencies, is very weak or inactive, depending on the exact nature of the mix-crystal structure—whether the ions X and Y are distributed regularly or statistically. A.

MOLECULAR STRUCTURE 539.13

539.13 : 535.338

4575. Isoconjugate spectra and variconjugate sequences. J. R. PLATT. *J. Chem. Phys.*, **19**, 101–18 (Jan., 1951).

Two molecules are *isoconjugate* or, more strictly, *iso- π -electronic* if they have the same number and geometrical arrangement of π -electrons bound about equally tightly in a planar conjugated system. A *variconjugate sequence* is a series of such molecules in which the binding of some of the π -electrons and the appearance of the spectra slowly changes. The π -spectrum of every organic molecule with a closed-shell ground state lies on a variconjugate sequence between the π -spectra of two conjugated hydrocarbons. An examination is made of the general problem of assigning observed electronic transitions in organic-molecule spectra to particular theoretically predicted transitions. It is shown how variconjugate sequences could be useful in making such assignments. A.

539.132

4576. On the form of molecular orbitals in conjugated rings and chains. F. G. FUMI. *Nuovo Cim.*, **8**, 1–25 (Jan., 1951).

A comparison of orbitals obtained for planar configurations (i) by Hückel's method, (ii) by use of group theoretical considerations due to Wigner, and (iii) in cases where some orbitals are incompletely filled, by Mulliken's technique. For chains the Hückel orbitals are linear, combinations of those obtained by Wigner's theorem. Applications to C_4H_4 , C_6H_6 , C_4H_6 , C_5H_7 . J. JACOBS

539.132

4577. Spectroscopic moment: a parameter of substituent groups determining aromatic ultraviolet intensities. J. R. PLATT. *J. Chem. Phys.*, **19**, 263–71 (March, 1951).

By the theory of Sklar and Forster, the added intensity produced in the benzene 2600Å transition by monosubstitution is proportional to the square of a transition moment or "spectroscopic moment" induced by the substituent. The sign of the moment may be positive or negative. On disubstitution, *para* intensities are greater than *meta* and *ortho* if both signs are the same, less if they are opposite. The theory is used with available data to determine the relative spectroscopic moment for 25 different substituents. This moment is closely related to the

"mesomeric moment" and to directing power, but the correlation is not perfect. The theory is extended to account for intensity changes in the weak long-wavelength transitions (${}^1A - {}^1L_b$) of derivatives of other cata-condensed ring systems, such as naphthalene, phenanthrene, 1,2-benzanthracene, etc. The increases of intensity produced by substituents, and their spectroscopic moments, appear to be almost identical with those found in benzene. A.

539.132

4578. On the interpretation of relaxation time measurements in gas mixtures. R. A. WALKER. *J. Chem. Phys.*, **19**, 494 (April, 1951).

Most studies of the excitation of molecular vibrations in gas mixtures have been carried out using very low concentrations of the B type "impurity" gas to excite basic gas A. It is pointed out in this paper that such studies very likely fail to detect the possible importance of triple collisions of the AAB type. Indeed, data of Eucken and Aybar on mixtures containing quite high concentrations of B molecules is felt to furnish strong evidence for the triple collision excitation of COS molecules by A and by N molecules. A.

539.132

4579. Erratum: Intermolecular forces in benzene and ammonia. V. MYERS. Letter in *J. Chem. Phys.*, **19**, 505 (April, 1951). See Abstr. 2889 (1951).

539.133

4580. Additions to the theory of the HCl molecule. J. I. HORVÁTH. *Z. Phys.*, **129** (No. 1) 56–61 (1951) In German.

The binding energy is determined as a combination of classical ionic exchange effects and polarization energy. The total polarization energy is computed additively from those of the closed L- and M-electron shells in the Cl-anion. The inhomogeneity of the field is still insufficiently accounted for, leading to a dissociation energy for ∞ removal of H of 12.688 eV. J. JACOBS

539.133

4581. An aid in making vibrational assignments. H. J. BERNSTEIN. Letter in *J. Chem. Phys.*, **18**, 1682 (Dec., 1950).

Frequencies calculated as guides for vibrational assignments are obtained using force constants derived from the simple potential function for the totally symmetrical type. A relation is deduced between the observed frequencies and the frequencies thus calculated. W. R. ANGUS

539.133

4582. The inclusion of van der Waals' forces in molecular potential functions. P. TORKINGTON. *Trans Faraday Soc.*, **47**, 105–12 (Feb., 1951).

The inclusion of van der Waals' forces in any given valence force potential function is discussed generally. A fundamental error in the Dennison-Urey-Bradley treatment is corrected. Sufficient examples of the application of the general methods are given to enable any individual case which arises to be treated rapidly. A.

539.133

4583. The calculation of the electric dipole moments of some conjugated heterocyclic compounds. L. E. ORGEL, T. L. COTTRELL, W. DICK AND L. E. SUTTON. *Trans Faraday Soc.*, **47**, 113–19 (Feb., 1951).

Six of the necessary parameters have been adjusted to give agreement with observed moment values, two have been derived from thermal data, and one is a value previously assigned in similar work. This semi-empirical procedure provides a useful means of predicting dipole moments and chemical reactivities. It gives bond orders similar to those which would be derived from a resonance hybrid treatment, but not corresponding to a linear combination of simple structures. A.

539.133

4584. Binding regions in diatomic molecules. T. BERLIN. *J. Chem. Phys.*, **19**, 208–13 (Feb., 1951).

The concept of intramolecular binding is given a precise definition in a way that relates binding to the forces acting on the nuclei in a diatomic molecule. A consequence of the definition is that the space around the nuclei may be separated into binding and antibinding regions. These regions are described and they depend on the Coulomb law of force and on the ratio of the nuclear charges; the internuclear distance is simply a scale parameter. The influence of a single electron on the binding due to other electrons is briefly discussed. A.

539.133

4585. Note on orthogonal atomic orbitals. J. C. SLATER. *J. Chem. Phys.*, **19**, 220–3 (Feb., 1951).

It is shown that orthogonal atomic orbitals, as introduced by Wannier for solid-state problems and by Löwdin for molecular problems, do not lead to a simple way of eliminating the non-orthogonality problem in the Heitler–London method. Thus, if a calculation of the H_2 molecule is made using orthogonal atomic orbitals in place of ordinary atomic orbitals, proceeding by the simple Heitler–London method, the resulting diagonal energy of the lowest state shows no energy minimum. The orthogonal atomic orbitals are suitable for use, however, if we make a complete perturbation calculation, and for this purpose they are as convenient as LCAO's, but not appreciably superior. A.

539.133

4586. The calculation of the change in vibrational frequency due to changes in mass, geometry, and potential constants of a molecule. H. J. BERNSTEIN. *Canad. J. Chem.*, **29**, 284–95 (March, 1951).

An expression for the change in vibrational frequency in terms of changes in the kinetic and potential energy of a molecule has been derived. For numerical calculations approximations are given. The change in frequency due to configurational changes has also been estimated in a qualitative manner. Finally, an approximate relation between the frequencies observed for a certain symmetry type and those calculated by means of force constants derived from some other symmetry type is given as an aid in assigning vibrational spectra. A.

539.133

4587. LCAO self-consistent field calculation of the ground state of carbon dioxide. J. F. MULLIGAN. *J. Chem. Phys.*, **19**, 347–62 (March, 1951).

LCAO molecular orbitals and ionization potentials have been calculated for the ground state of CO_2 using Roothaan's LCAO self-consistent field method. The interactions of all electrons have been explicitly considered, and no extra-geometrical empirical data have been used. The calculated molecular orbitals are in general agreement with those predicted by Mulliken and Moffitt from semi-empirical considerations. The calculated ionization energies are 11.5 eV for a $1\pi_g$ electron and 17.9 eV for a $2\sigma_u$ electron, compared with the experimental 13.8 eV, and 18.0 eV, respectively. The evaluation of the large number of integrals over atomic orbitals that occur is discussed in an appendix. All the larger integrals were calculated exactly, the smaller ones approximated. Useful approximation methods for some of these integrals are considered. A.

539.133

4588. LCAO self-consistent field calculation of the twisting frequency and π -electron energy levels of allene. R. G. PARR AND G. R. TAYLOR. *J. Chem. Phys.*, **19**, 497 (April, 1951).

The twisting frequency of allene is computed by the non-empirical method of antisymmetrized products of molecular orbitals in self-consistent field LCAO approximation, as applied to the four unsaturation electrons of the molecule, molecular orbitals for these electrons being taken as linear combinations of 2p Slater atomic orbitals. By comparison with a previous calculation by the same method on ethylene, the ratio of the twisting frequency of ethylene to the twisting frequency of allene is computed to be 1.7, sensibly independent of the effective charge in the atomic orbitals, which is the only extrageometrical parameter entering the theoretical calculations. The first ionization potential of allene is predicted to be 10.4 eV and the mean of the first allowed singlet electronic absorption band and the corresponding triplet is predicted to lie at 5.1 eV. A.

539.133 : 537.525

4589. A mechanism of formation of nitric oxide in glow discharges. R. W. NICHOLLS. Letter in *J. Chem. Phys.*, **19**, 250 (Feb., 1951).

Collision between normal O_2 with N_2 in the excited $B^3\Pi_g$ state may lead to formation of one normal and one excited NO molecule. Resonances between vibrational levels of $N_2(B^3\Pi_g)$ with those of excited states of NO are discussed. A. G. GAYDON

539.133 : 539.27

4590. Electron diffraction by transmission through thin liquid films. C. W. LUFKY, F. S. PALUBINSKAS AND L. R. MAXWELL. *J. Chem. Phys.*, **19**, 217–20 (Feb., 1951).

Electron interference has been obtained by the transmission of 50 kV electrons through thin liquid films of the silicones: DC703, DC500 and DC200; and the hydrocarbons: octoil, castor oil and glycerine. A commercial electron microscope (RCA, type EMU) was used after modification of the specimen.

holder. The electron diffraction patterns obtained from the hydrocarbons were all practically the same. They were characterized by 3 complete diffraction halos. The Bragg spacings (d) for octoil were found to be 4.93Å, 2.26Å and 1.23Å. These distances compare closely with values obtained previously for electron diffraction in liquid phytol ($C_{20}H_{39}OH$), Nujol and Cenco pump oil. The patterns obtained for the silicones were significantly different from those of the hydrocarbons. Four complete rings were observed for DC703, giving d values of 8.17Å, 4.18Å, 1.97Å and 1.27Å. The DC500 and DC200 fluids showed only 3 rings with Bragg spacings of 7.40Å, 3.96Å and 1.27Å; the ring which occurred at $d = 1.97Å$ for DC703 was absent. The accepted Si—O distance of 1.60Å is in agreement with the above data; however, the Si—O—Si—O angle is found to be approximately 104°. Such conclusions were confirmed by density calculations. A.

539.133 : 541.57

4591. The role of hybridization and resonance in molecular structure. J. DUCHESNE. *J. Chem. Phys.*, **19**, 246-7 (Feb., 1951).

It is shown that hybridization of the end-atoms in multiple-bonded molecules, as well as in single-bonded ones, is necessary for the understanding of the chemical bond properties. Resonance effects seem to play a minor role, except for conjugated systems. A.

ATOMIC STRUCTURE . NUCLEUS ISOTOPES 539.15

539.152.1

4592. The interpretation of metastable nuclear energy-levels. A. LUNDBY. *Forsvarets ForsknInst. Arb.*, **2**, 18-28 (1948-49).

A short review.

A. O. STANESBY

539.152.1

4593. On the binding energies of the atomic nuclei ^2H , ^3H , ^3He and ^4He . I. H. W. PENG AND M. Y. TANG. *Chin. J. Phys.*, **7**, 316-23 (Sept., 1950).

These are calculated with a spin-dependent meson potential and a wave-function in all cases of the form

$$\phi = \exp(-a\lambda g/\sqrt{2}), \text{ where } g^2 = \frac{1}{2A} \sum_{i,j=1}^A |r_i - r_j|^2.$$

Potential constants, for meson masses $M/10$ and $M/6$, were chosen to give the two deuteron levels correctly by an exact calculation (λ is the reciprocal potential range). The parameter a is chosen to minimize the energy by the usual variation method. The energies of the nuclei in the states indicated. The calculated energies obtained for the nuclei H^2 (triplet), H^3 (doublet), He^3 (doublet) and He^4 (singlet) in that order, are 2.13, 7.25, 6.40 and 32.6 MeV for $M/10$ and 1.73, 10.44, 9.34 and 59.7 MeV for $M/6$. These compare with experimental values quoted 2.19, 8.39, 7.65 and 28.20 MeV. Results are obtained in analytic form. G. J. KYNCH

539.152.1

4594. On the binding energies of the atomic nuclei ^2H , ^3H , ^3He and ^4He . II. S.-N. KING, C.-H. CHANG AND H. W. PENG. *Chin. J. Phys.*, **7**, 331-8 (Sept., 1950).

The discrepancy between the experimental binding energies and those calculated in Part I for a meson mass of 286 cannot be removed by improving the wave-functions. In this part the two potential constants are determined not by the triplet and singlet deuteron states but by the triplet deuteron state and either (a) the binding energy of H^3 or (b) of He^4 . The large difference in the two sets of values shows the inconsistency of explaining the four binding energies using this potential form. The improved eigenfunction contained other terms besides the completely symmetric term, for example, for He , terms antisymmetric in pairs of particles of the form $a^2\lambda^2b(r_4 - r_1, r_2 - r_3)\phi$, where ϕ is defined in Part I. G. J. KYNCH

G. J. KYNCH

539.152.1

4595. The binding energies of the atomic nuclei. III. C.-H. CHANG AND H. W. PENG. *Chin. J. Phys.*, **7**, 348-61 (Sept., 1950).

Parts I and II are extended, abandoning the assumption of charge independence, with a potential $C_{12}[g^2 + f^2(\sigma_1\sigma_2)](e^{-\lambda r}/r) + N_{12}[g_0^2 + f_0^2(\sigma_1\sigma_2)]e^{-\lambda_0 r}/r$ where $C_{ij} = \frac{1}{2}(\tau_{i1}\tau_{j1} + \tau_{i2}\tau_{j2})$ and $N_{ij} = \tau_{i3}\tau_{j3}$ or 1 as the interaction of the neutral meson field contains the factor τ_3 or not. The wave-function used is that used in Part I. The binding energies of H^3 and He^4 (8.4 and 29.0 MeV) being assumed, ($g^2 + 3f^2$) and a function of g_0 and f_0 are determined as functions of $(\mu/\mu_0) = (\lambda_0/\lambda)$ from 0.1 to 10.0. The triplet deuteron energy gives a further relation between the constants. The non-existence of a bound state between two neutrons is shown to demand $(\mu/\mu_0) < 1$. The absence of a bound singlet deuteron state requires $N = 1$. Final tables give potential constants for the ratio (μ/μ_0) between 0.6 and 0.9 (other values give incompatible results). The constants are much larger than for the Moller-Rosenfeld mixture, g^2 , f^2 , g_0^2 and f_0^2 (times $M/\mu hc$) being 12.1, 4.0, 14.2 and 5.6 for $\mu/\mu_0 = 0.7$. G. J. KYNCH

539.152.1

4596. Nuclear moments and nuclear models. H. KOPFERMANN. *Naturwissenschaften*, **38** (No. 2) 29-34 (1951) In German.

A review is given of present knowledge regarding spins and magnetic and quadrupole moments. It is shown how, starting with the simple single-particle model, through the spin-orbit coupling scheme of M. Goeppert-Mayer [*Phys. Rev.*, **74**, 235 (1948)] and the "asymmetric" model of A. Bohr [Abstr. 2925 (1951)] the theoretical interpretation has progressed to a stage so complete as to offer a contradiction to the conventional Bohr model of the nucleus where the individuality of the nucleons is lost due to their strong mutual interactions. A possible explanation in terms of an analogy with the properties of conduction electrons in metals is suggested: for energies below the Fermi energy the strong interaction between the electrons is not fully effective owing to the limitations

on the transitions imposed by Pauli's principle; the description in terms of free particles is therefore good for low but not for high energies. W. J. SWIATECKI

539.152.1

4597. On the nuclear moments of the Ag isotopes and the isotope shift in the spectrum of silver. P. BRIX, H. KOPFERMANN, R. MARTIN AND W. WALCHER. *Naturwissenschaften*, **38** (No. 3) 68-9 (1951) *In German*.

A direct experiment on electromagnetically separated samples of Ag^{107} and Ag^{109} leads to an assignment of the hyperfine structure components of the line $5s^2S_{1/2} - 5p^2P_{3/2}$ ($\lambda = 3281 \text{ \AA}$) between the two isotopes which differs from previous indirect results. It follows that the values of the nuclear magnetic moments are to be replaced by -0.111 and -0.129 respectively. The isotope shift of the $5s^2S_{1/2}$ term has then the expected sign and magnitude.

W. J. SWIATECKI

539.152.1

4598. The isotopic weight of helium. K. T. BAINBRIDGE. Letter in *Phys. Rev.*, **81**, 146-7 (Jan. 1, 1951).

Suggests that a more satisfactory isotopic weight scale than that of Tollestrup, Fowler and Lauritsen [Abstr. 6681 (1950)] can be based on a value for He^4 obtained from the mass-spectrograph doublet ($2D^2 - \text{He}^4$). This doublet can be derived from Q -value cycles alone; results of 3 cycles differ from mass spectrograph data by 2-4 times the probable errors of the Q measurements or 12-30 times those of the mass spectrograph data. The error seems to be mainly in the Q -values of $\text{Li}^7(p, \alpha)\text{He}^4$ and $\text{Li}^6(d, \alpha)\text{He}^4$. From 3 basic doublets, the following values are given: $n = 1.0089785$, $\text{H}^1 = 1.0081386$,

38
32

$D^2 = 2.0147252$, $\text{He}^4 = 4.003842$, $\text{C}^{12} = 12.003895$.

57
13
19

T. G. PICKAVANCE

539.152.1

4599. A note on Rainwater's spheroidal nuclear model. E. FEENBERG AND K. C. HAMMACK. Letter in *Phys. Rev.*, **81**, 285 (Jan. 15, 1951).

The energy term, linear in the eccentricity, due to the shift of the eigenvalue of the particle outside the core, is calculated exactly. The result checks with the approximate value given by Rainwater [Abstr. 8911 (1950)] under his limiting conditions. The accurate value probably eliminates the possibility of excessive moments suggested by Rainwater.

J. HUGHES

539.152.1

4600. On the displacement of corresponding energy levels of C^{13} and N^{13} . J. B. EHRLMAN. *Phys. Rev.*, **81**, 412-16 (Feb. 1, 1951).

It is investigated to what extent the change in boundary conditions at the nuclear surface due to Coulomb wave function distortion in the external region can explain the relative displacement of the first excited states of C^{13} and N^{13} . It is found that the calculated displacement is in the right direction and of a sufficiently large magnitude, but rather sensitively dependent on the definition of nuclear radius. A.

539.152.1

4601. The nuclear spin of Be^9 . H. S. GUTOWSKY, R. E. MCCLURE AND C. J. HOFFMAN. Letter in *Phys. Rev.*, **81**, 635-6 (Feb. 15, 1951).

The value $\frac{3}{2}$ is confirmed by observations of the detailed line shape of the F^{19} magnetic resonance in BeF_2 and K_2BeF_4 . W. J. SWIATECKI

539.152.1

4602. The effective range of nuclear forces. Effect of the potential shape. E. E. SALPETER. *Phys. Rev.*, **82**, 60-6 (April 1, 1951).

Corrections to the theory of the effective range, which take account of the shape of the neutron-proton potential, are discussed. The following quantities are calculated for a Yukawa, exponential and square well potential: (a) various triplet ranges compatible with the value obtained for $\rho_t(0, -\epsilon)$ from the latest experiments, $(1.72 \pm 0.035) \times 10^{-13} \text{ cm}$; (b) the singlet effective range r_{os} from neutron-proton scattering cross-sections at energies up to 6 MeV; (c) r_{os} from neutron absorption cross-sections by H; (d) photo-electric and photo-magnetic disintegration cross-sections for the deuteron for various γ -rays. It is shown that a comparison of the values obtained for r_{os} from (b) and (c) could, with a slight increase in experimental accuracy, give an estimate of the potential shape. Present, very tentative, indications are for a short-tailed potential and a value for r_{os} of about $(2.7 \pm 0.5) \times 10^{-13} \text{ cm}$. A.

539.152.1

4603. The density of states in light nuclei. C. L. CRITCHFIELD AND S. OLEKSA. *Phys. Rev.*, **82**, 243-7 (April 15, 1951).

The number of states of energy less than 25 MeV is calculated for a simple model of a nucleus of 20 nucleons. Kinetic energy and the effect of symmetry on the potential energy were considered to be the only systematic contributions to the excitation. A method of classification of states by supermultiplets, using mainly their projections on the S - T plane, is presented. An empirical formula for level density in light nuclei is deduced. A.

539.152.2

4604. A diagram for the evaluation of unknown nuclear magnetic moments. O. RIEDEL. *Z. Naturforsch.*, **5a**, 654-7 (Dec., 1950) *In German*.

If the known magnetic moments for even-odd and odd-even nuclei are separately plotted as functions of mass number with the nuclear spin as parameter, fairly smooth curves are obtained in some cases (deviations are correlated with "magic numbers") from which by interpolation the signs and approximate magnitudes of unknown magnetic moments can be deduced. The appearance of the curves is taken to suggest that in a nucleus of spin $x/2$, x nucleons add their spins and magnetic moments to form the total spin and total magnetic moment respectively.

W. J. SWIATECKI

539.152.2

4605. Magnetic shielding of the proton resonance in H_2 , H_2O , and mineral oil. H. S. GUTOWSKY AND R. E. MCCLURE. Letter in *Phys. Rev.*, **81**, 277 (Jan. 15, 1951).

These shieldings were measured because proton

resonances in water and mineral oil are frequently used as standards. The theoretical value for the m.s. in H_2 can be combined with these data to reduce observations to the unshielded proton. Experimental methods were similar to those previously described [Abstr. 1976 (1951)], but now the field of the permanent magnet was constant to 0.15 gauss over a volume 2 in. in dia. and 1 in thick. The fractional effect was found to be of the order of 10^{-6} , and thus the absolute value of the proton magnetic moment is unaffected, as differences in magnetic shielding constitute only about 5% of the stated error in the best determinations.

L. PINCHERLE

539.152.2

4606. Nuclear audiofrequency spectroscopy by resonant heating of the nuclear spin system. N. F. RAMSEY AND R. V. POUND. Letter in *Phys. Rev.*, **81**, 278-9 (Jan. 15, 1951).

The method is based on the long relaxation time of a pure single crystal of LiF: the crystal is removed from a strong magnetic field for a time short compared to the zero field relaxation time (15 sec) and is placed in an audiofrequency magnetic field. The ratio of the nuclear magnetization immediately before and immediately after the removal from the strong field is measured as a function of the frequency f of the audio-oscillator. There is a dependence on f because of resonant heating of the nuclear spin system. With an audiofrequency field of 0.2 gauss, heating takes place for $10^3 < f < 10^5$. When the amplitude of the a.f. field was reduced to 0.018 gauss applied for 3 sec, a maximum was observed at 50 kc/s with a width of 45 kc/s. The effect on the spectrum of a constant external magnetic field was also investigated.

L. PINCHERLE

539.152.2

4607. A nuclear spin system at negative temperature. E. M. PURCELL AND R. V. POUND. Letter in *Phys. Rev.*, **81**, 279-80 (Jan. 15, 1951).

A sufficiently rapid reversal of the direction of the magnetic field must result in a magnetization opposed to the new sense of the field. The effect was demonstrated with a long relaxation time single crystal of LiF. The reversal must occur in a time $< 20 \mu\text{sec}$, so that the system cannot follow the change adiabatically. Statistically the state of the spin system after reversal may be described by a negative temperature: it decays to a normal state through infinite temperature.

L. PINCHERLE

539.152.2

4608. On the nuclear magnetic moment of Na^{23} . R. A. LOGAN AND P. KUSCH. Letter in *Phys. Rev.*, **81**, 280 (Jan. 15, 1951).

The nuclear g values for Na in the state $^2S_{1/2}$ were measured by h.f.s. and nuclear magnetic resonance observations. No discrepancy of the kind observed with Ga and In in $^2P_{3/2}$ appears. This is argued to support Foley's contention [Abstr. 1977 (1951)] that the discrepancy in the latter case is explained by L - S decoupling by the magnetic field used in the h.f.s. measurements.

J. R. MADDUX

539.152.2

4609. Ratio of quadrupole moments of Cl^{35} and Cl^{37} . S. GESCHWIND, R. GUNTHER-MOHR AND C. H.

TOWNES. Letter in *Phys. Rev.*, **81**, 288-9 (Jan. 15, 1951).

In view of the discrepancies in recent measurements of this ratio a redetermination was made using CH_3Cl , $ClCN$ and GeH_3Cl . The results (1.2691 ± 0.0003 , 1.2682 ± 0.0006 , 1.2670 ± 0.0005) differ by significant amounts. In the case of $Br^{79,81}$ in $BrCN$ and CH_3Br no discrepancy is found (see Abstr. following).

W. J. SWIATECKI

539.152.2

4610. Polarization of the nucleus by electric fields. G. R. GUNTHER-MOHR, S. GESCHWIND AND C. H. TOWNES. Letter in *Phys. Rev.*, **81**, 289-90 (Jan. 15, 1951).

In view of the discrepancy discussed in preceding Abstr., and after discarding 4 other explanations as too small by an order of magnitude, it is suggested that the difference in the ratios of the quadrupole moments arises out of a polarization of the $Cl^{35,37}$ nuclei by the electric field of the molecule. A theoretical calculation of the dependence of polarizability on the mass of the nucleus shows that an effect of the right order of magnitude is possible.

W. J. SWIATECKI

539.152.2

4611. Nuclear magnetic moments and atomic hyperfine structure. A. BOHR. *Phys. Rev.*, **81**, 331-5 (Feb. 1, 1951).

The asymmetric nuclear model discussed in a previous paper [Abstr. 2925 (1951)] provides the basis for a more detailed interpretation of nuclear magnetic moments than the single particle model permits. The structure of the moment which the model implies may be tested by a study of the influence of the finite size of the nucleus on the atomic h.f.s. This effect was investigated previously in co-operation with Weisskopf, and is considered more closely in the present paper with the assumption that the nuclei in question can be described in terms of a single particle moving in an asymmetric nuclear core. The K-isotopes should be well represented by this model, and for these nuclei the theoretical value obtained for the h.f.s. is in close agreement with the observed data. Also for the Rb-isotopes the agreement is satisfactory.

A.

539.152.2

4612. A sensitive method of recording nuclear induction signals. I. M. ROSS AND F. B. JOHNSON. Letter in *Nature, Lond.*, **167**, 286-7 (Feb. 17, 1951).

The signal-to-noise ratio is improved by photographing the signal on an oscilloscope screen; after each exposure the film is advanced and the magnetic field increased or decreased by a small increment. The signal then appears as a sloping trace on the raster formed by successive exposures.

J. HUGHES

539.152.2

4613. The time average magnetic field at the nucleus in nuclear magnetic resonance experiments. W. C. DICKINSON. *Phys. Rev.*, **81**, 717-31 (March 1, 1951).

For the high-precision measurement of a nuclear gyromagnetic ratio by the Purcell or Bloch resonance methods, accurate knowledge of the time-average magnetic field H_{Av} at the positions of the nuclei is necessary. The various component fields contributing

to H_{Av} are listed. An experimental study is made of two of these fields: the magnetic-shielding field in molecules and the magnetization field of paramagnetic ions added to a sample. The effect of these fields on the attainable precision in the measurement of nuclear moments is discussed. A.

539.152.2

4614. Magnetic moment of the deuteron. B. SMALLER, E. YASAITIS AND H. L. ANDERSON. Letter in *Phys. Rev.*, **81**, 896-7 (March 1, 1951).

A precision measurement of the ratio R of the magnetic moment of the proton to that of the deuteron, carried out with the magnetic resonance method, gave the result $R = 3.2571990 \pm 0.0000010$. L. PINCHERLE

539.152.2

4615. Spin-orbit coupling in Li^7 and Be^7 . D. R. INGLIS. *Phys. Rev.*, **82**, 181-9 (April 15, 1951).

The magnetic spin-orbit coupling of the p -shell nucleons is shown to have the correct sign and about half the magnitude to account for the 45 keV difference of the first excitation energies, 479 keV in Li^7 and 434 keV in Be^7 , if these are interpreted as doublet splittings arising mainly from a spin-orbit coupling term of the same form as the Thomas term but stronger and presumably of mesonic origin, such as seems to be responsible for the appearance of (jj) coupling in heavy nuclei. Be^7 is expected to be slightly larger than Li^7 because of the added Coulomb repulsion, so that the average value of the main term is expected to be smaller for Be^7 , and it is estimated that this Coulomb expansion explains another one-fourth to the splitting difference, leaving about one-fourth unaccounted for. These estimates are made both very simply by means of the droplet model and more reliably by minimizing the energy obtained with exchange interactions and 3-dimensional isotropic oscillator wave functions. Energies attributed to spin-orbit coupling in other nuclei indicate that the main term should make the Li^7 and Be^7 doublet splittings about 50% larger than observed. This suggests that 2nd-order perturbations may reduce both by nearly the same amount, leaving their estimated difference significant. The possibility of more drastic perturbations and their relation to the quadrupole-moment problem are discussed. The agreement of the estimated splitting difference in sign and order of magnitude is consistent with other evidence favouring the (LS)-coupling interpretation that the 2 low states form a 2^2P . A.

539.153 : 538.114

4616. Interaction between the d shells in the transition metals. C. ZENER. *Phys. Rev.*, **81**, 440-4 (Feb. 1, 1951).

It is assumed (1) that the interaction between the incomplete d shells of the transition elements is insufficient to disrupt the coupling between the d electrons in the same shells, and (2) that the exchange interaction between adjacent d shells always has the same sign irrespective of distance of separation. The direct interaction between adjacent d shells then invariably leads to a tendency for an antiferromagnetic alignment of d spins. The body-centred cubic structure of the transition metals V, Cr, Cb, Mo, Ta and W

is thereby interpreted, as well as more complex lattices of certain alloys. It is demonstrated that the spin coupling between the incomplete d shells and the conduction electrons leads to a tendency for a ferromagnetic alignment of d spins. The occurrence of ferromagnetism is thereby interpreted in a much more straightforward manner than through the *ad hoc* assumption of a reversal in sign of the exchange integral. The occurrence of antiferromagnetism and of ferromagnetism in various systems is readily understood, and certain simple rules are deduced for deciding which type of magnetism will occur in particular alloys. A.

539.154.2

4617. The classifying of atomic nuclei occurring in nature. J. HÉLY. *Rev. Sci., Paris*, **88**, 30-3 (Jan.-March, 1950) In French.

It is found that the mass number A and the number of neutrons $A-Z$, and $A-Z$ and the atomic number Z , are simply related. Three main types of nuclei are found depending on the particular relation existing. J. HUGHES

539.155.1

4618. The mass of S^{32} . H. E. DUCKWORTH, G. S. STANFORD, J. M. OLSON AND C. L. KEGLEY. Letter in *Phys. Rev.* **81**, 286 (Jan. 15, 1951).

4619. The atomic masses of H^1 , C^{12} , and S^{32} . A. O. NIER. Letter in *Phys. Rev.* **81**, 624 (Feb. 15, 1951).

Four doublets were studied in a double-focusing mass spectrometer to give results relative to O^{16} . Mass spectrometric values for 9 isotopes from H^1 to A^{40} are tabulated. T. G. PICKAVANCE

539.155.1

4620. The H_2 -D mass difference and the determination of secondary atomic mass standards. T. R. ROBERTS. Letter in *Phys. Rev.*, **81**, 624-5 (Feb. 15, 1951).

A double-focusing mass spectrometer was used to give an H_2 -D difference of $15.519 \pm 0.017 \times 10^{-4}$ m.u., in agreement with nuclear data. Values for H, D and n computed from this and two other mass spectrometer doublets differ from those quoted by Bainbridge [*N.R.C. Prelim. Rep. No. 1, Nuclear Sci. Ser.* (1948)] by about 10 times the probable errors. T. G. PICKAVANCE

539.155.1

4621. The determination of atomic mass doublets by means of a mass spectrometer. A. O. NIER AND T. R. ROBERTS. *Phys. Rev.*, **81**, 507-10 (Feb. 15, 1951).

A double-focusing mass spectrometer employing a 90° electrostatic analyser followed by a 60° magnetic analyser has been constructed having a resolution sufficiently great to permit mass difference measurements by the familiar doublet method. High stability is obtained by use of an auxiliary mass-spectrometer tube which compensates for fluctuations in both the magnetic field and the source of potential for the deflecting and accelerating plates of the main spectrometer. Ion currents are measured electrically and data recorded automatically. The doublets determined and their values in 10^{-4} amu are as follows: $D_2O^{16}-A^{40}/2$, 419.67 ± 0.18 ; $D_2O^{16}-Ne^{20}$, $307.21 \pm$

0.39; $\text{Ne}^{20}\text{-A}^{40}/2$, 112.80 ± 0.18 ; $(\text{C}^{12})_3\text{H}_4\text{-C}^{12}\text{O}^{16}$, 364.43 ± 0.22 ; $(\text{N}^{14})_2\text{-C}^{12}\text{O}^{16}$, 112.80 ± 0.13 ; $(\text{C}^{12})_3\text{H}_8\text{-(N}^{14})_2\text{O}^{16}$, 617.6 ± 0.9 ; $\text{C}^{12}\text{H}_4\text{-O}^{16}$, 364.78 ± 0.22 ; $\text{C}^{12}\text{H}_2\text{-N}^{14}$, 125.86 ± 0.13 ; $(\text{C}^{12})_3\text{H}_4\text{-A}^{40}$, 688.77 ± 0.35 ; $(\text{C}^{12})_3\text{H}_4\text{-Ca}^{40}$, 685.39 ± 0.46 ; $\text{Ca}^{40}\text{-A}^{40}$, 3.2 ± 0.8 ; $\text{D}_2\text{-He}^4$, 256.12 ± 0.09 ; $\text{H}_2\text{O}^{16}\text{-A}^{36}/2$, 267.02 ± 0.40 . A.

539.155.1 : 535.343.4-14

4622. Microwave study of Ge, Si, and S masses. S. GESCHWIND AND R. GUNTHER-MOHR. Letter in *Phys. Rev.*, **81**, 882-3 (March 1, 1951).

Mass difference ratios for S and Si from microwave spectra are in agreement with mass spectroscopic values and substantiate the accuracy of the microwave method. Measurements on GeH_3Cl lead to Ge^{72} and Ge^{76} masses and masses of Ge and S isotopes are compared with the Bohr-Wheeler formula with moderate agreement, the experimental curve having a slightly smaller curvature.

D. H. WHIFFEN

539.155.2

4623. Mass spectrometric determination of deuterium by means of phosphine. H. VON UBISCH. *Ark. Fys.*, **2**, Paper 47, 517-22 (1951).

Phosphine, prepared by passing vapour from a few drops of water over magnesium phosphide, was admitted directly into a 180° mass spectrometer. A pyrex tube and gold-plated metal parts were used. D : H ratios in tap water were measured as PH_2D^+ : PH_2^+ with very small or no background and with $\sim 5\%$ reproducibility. Admission of H left the mass spectra of phosphine from tap water and heavy water unchanged; therefore no PH_2^+ ions are formed and there is no trouble analogous to the occurrence of H_3^+ in H analysis. Exchange of H mostly takes place in the adsorbed phase; this is troublesome in causing "memory" effects, but the phosphine method compares favourably with H analysis. Mass spectra are given for samples of low and high D concentration.

T. G. PICKAVANCE

539.155.2

4624. Intramolecular isotopic fractionation—the example of nitrous oxide. J. M. MCCREA. *J. Chem. Phys.*, **19**, 48-9 (Jan., 1951).

The spectroscopic results of Richardson and Wilson [Abstr. 7124 (1950)] are used to calculate the partition function ratios for the isotopic species of NO. A number of approximate calculations of types often necessary in other cases owing to limited data are given to show the errors introduced by these approximations. A.

539.155.2

4625. A method of isotopic separation by (n, γ) recoil. L. B. MAGNUSSON. Letter in *Phys. Rev.*, **81**, 285-6 (Jan. 15, 1951).

539.155.2

4626. The theory of the separation of isotopes by thermal diffusion. S. D. MAJUMDAR. *Phys. Rev.*, **81**, 844-8 (March 1, 1951).

The time-dependent partial differential equation of the "separation column" of Clusius and Dickel has been solved exactly. Only an approximate solution,

subject to the restriction that the fractional concentration c is everywhere small compared to unity, was known previously. The present work makes a comparison between theory and experiment possible over the full range of concentration values. A.

RADIOACTIVITY . α -, β - AND γ -RAYS 539.16

539.16.08

4627. Measurement of low level radiocarbon. E. C. ANDERSON, J. R. ARNOLD AND W. F. LIBBY. *Rev. Sci. Instrum.*, **22**, 225-30 (April, 1951).

Techniques are described for chemical purification and measurement of radiocarbon at natural levels (10^{-12} curie/g or less). The chemical cycle has the following steps: (1) conversion of the starting material to CO_2 , by combustion or hydrolysis, (2) precipitation as CaCO_3 , followed by evolution of the purified CO_2 ; (3) reduction to elementary C with Mg turnings, and (4) extraction with HCl and water to remove Mg and MgO. The overall yield is about 85%, based on the C in the original sample. The counting is done in a screen-wall counter, 24 in long, with an 8 in effective counting length. The sample (about 8.5 g) is mounted uniformly in an "infinitely thick" layer, on a split cylinder which can be shifted from "sample" to "background" position by sliding from end to end of the counter. An argon-ethylene filling is used. The background of the counter (about 400 c.p.m., unshielded) is reduced to 4.5 c.p.m. by the use of an 8 in thick iron shield and 11 anti-coincidence counters, 18 in long. The calibration of the counter on an absolute basis is described. Its efficiency for a 20 mg/cm^2 layer of C, over a 400 cm^2 area, is $5.46 \pm 0.03\%$. A.

539.16.08

4628. Leak location by radioactive gases in buried pipes. A. GEMANT, E. HINES AND E. L. ALEXANDERSON. *J. Appl. Phys.*, **22**, 460-4 (April, 1951).

Describes basic considerations and experiments on leak location by means of radioactive tracer gases in underground pipes. C-14 labelled CO and Rd were used as tracers. The principles of the method are described. Suitable techniques for preparing and detecting the tracer gas have been worked out. Calculations on the spreading of a column of tracer gas in a pipe follow. Leak location on two small-scale installations was carried out experimentally. A.

539.16.08 : 518.5

4629. An isotope calculator. W. S. EASTWOOD. *Atomics, Lond.*, **2**, 81-2 (March, 1951).

A circular slide rule has been developed for the calculation of the specific activity of radio-isotopes produced by neutron irradiation. Saturation activity is first calculated in terms of flux, cross-section and atomic weight, using six-cycle logarithmic scales so that order of magnitude ambiguity is avoided. Specific activity is then found in terms of saturation activity, half-life and irradiation time. Decayed values of sources may also be determined.

T. G. PICKAVANCE

539.16.08 : 53.081.1
4630. The r -unit at 320 and 160 MeV. E. M. McMILLAN, W. BLOCKER AND R. W. KENNEY. Letter in *Phys. Rev.*, **81**, 455 (Feb. 1, 1951).

539.16.08 : 541.14/15
4631. A simplified chemical method of radiation dosimetry. M. E. J. CARR. Letter in *Nature, Lond.*, **167**, 363-4 (March 3, 1951).

Describes a new method of determining doses of ionizing radiations of the order of 20 000 r . The use of the Folin-Ciocalteu reagent is dispensed with, the amount of phenols produced being estimated directly by absorptiometry. Within the 5 000–25 000 r range, the measurements can be reproduced within $\pm 3\%$.

F. LACHMAN

539.16.08 : 778.3
4632. On the use of photographic "nuclear research" emulsions for the microradiographic examination of rocks and the study of radioactive inclusions. R. COPPENS. *C.R. Acad. Sci., Paris*, **232**, 724-5 (Feb. 19, 1951) *In French*.

To assist in identifying small and weakly radioactive inclusions in thin slices of rock, microradiographs have been taken on nuclear research emulsions. The radioactive inclusions are mainly due to heavy elements and give rise to clear spots in the microradiograph. Such microradiographs must be examined in conjunction with an emulsion exposed to alpha particles from the specimen in order to identify which of the heavy inclusions are radioactive.

A. C. COATES

539.162
4633. The capture of orbital electrons by nuclei (K -capture). C. S. COOK. *Amer. J. Phys.*, **19**, 37-47 (Jan., 1951).

The paper presents a review of recent work on K -capture of orbital electrons by nuclei, including a simple outline of the underlying theory and a discussion of the conditions under which the phenomenon occurs. A brief description is given of the instruments and methods used to observe K -capture. A.

539.163.1
4634. Erratum: Experiments on the effect of atomic electrons on the decay constant of Be^7 . II. R. F. LEININGER, E. SEGRÈ AND C. WIEGAND. Letter in *Phys. Rev.*, **81**, 280 (Jan. 15, 1951).

See Abstr. 1157 (1950).

539.163.1
4635. Erratum: Experiments on the effect of atomic electrons on the decay constant of Be^7 . E. SEGRÈ AND C. E. WIEGAND. Letter in *Phys. Rev.*, **81**, 284 (Jan. 15, 1951). See Abstr. 2664 (1949).

539.163.1
4636. The half-life of Na^{24} . J. H. SREB. Letter in *Phys. Rev.*, **81**, 469 (Feb. 1, 1951).

539.163.1
4637. The absence of cross-over transitions in tellurium isomers. R. D. HILL. Letter in *Phys. Rev.*, **81**, 470-1 (Feb. 1, 1951).

Weisskopf's new formula (unpublished) for electric and magnetic n -pole radiation probabilities gives an improved agreement with decay times of Te^{121} , ^{123} , ^{125} isomers.

W. J. SWIATECKI

539.163.1
4638. The half-life of I^{131} . J. H. SREB. Letter in *Phys. Rev.*, **81**, 643 (Feb. 15, 1951).

539.163.1
4639. Half-life of the long-lived Te^{99} . S. FRIED, A. H. JAFFEY, N. F. HALL AND L. E. GLENDENIN. *Phys. Rev.*, **81**, 741-7 (March 1, 1951).

The half-life of Te^{99} has been determined on materials isolated both from fission products and from irradiated Mo. The determinations were made on aliquots of solutions prepared by dissolving weighed portions of compounds of known composition. The counts were made absolute by comparing them with Co^{60} and RaDEF standards. These determinations resulted in a value of 2.12×10^5 yr for the half-life of Te^{99} . A detailed description of the absolute beta-counting techniques is given.

A.

539.163.1
4640. Half-lives of some radioactive isotopes. W. K. SINCLAIR AND A. F. HOLLOWAY. Letter in *Nature, Lond.*, **167**, 365 (March 3, 1951).

Measurements of the decay of 9 radioactive isotopes were made over 3-5 $\frac{1}{2}$ -lives, taking adequate precautions to check escape of the activity, with the following results ($\frac{1}{2}$ -lives with probable errors): K^{42} : 12.5 ± 0.2 hr; Na^{24} : 15.0 ± 0.1 hr (in agreement with Solomon [Abstr. 8938 (1950)]; see also Sreb [preceding Abstr.]); Br^{82} : 35.7 ± 0.3 hr; Au^{198} : 2.72 ± 0.01 and 2.74 ± 0.015 d; I^{131} : 8.04 ± 0.04 d; P^{32} : 14.59 ± 0.03 d; Ir^{192} : 74.5 ± 0.7 d; Ta^{182} : 111 ± 1 d; Co^{60} : 5.25 ± 0.21 yr. A. O. STANESBY

539.163.2
4641. Preparation of Th^{235} and Pa^{235} . B. G. HARVEY AND B. I. PARSONS. Letter in *Phys. Rev.*, **80**, 1098-9 (Dec. 15, 1950).

Th^{234} was separated from U by ether extraction and Co-precipitation with ferric hydroxide followed by 4 precipitations with a lanthanum fluoride carrier. The Th^{234} was freed from Pa isotopes by dissolving in 6M HNO_3 and extraction with di-isopropyl ketone. The Th^{234} soln. was evaporated in a silica tube and irradiated for 45 min in a flux of 6×10^{13} neutron/cm²/sec in NRX pile. Pa isotopes were separated from the irradiated sample by di-isopropyl ketone extraction and additional purifications carried out to remove any remaining traces of La^{140} , Th^{234} and fission products, the Pa being finally obtained in an evaporated deposit on Al. The 23 ± 1.5 min half-life decay of Pa^{235} was detected in an end-window β -counter in addition to 1.14 min and 6.7 hr Pa^{234} activities. The Pa^{235} is formed by β -decay of Th^{235} which was obtained in this case by the reaction $\text{Th}^{234}(n, \gamma)\text{Th}^{235}$ with a cross-section estimated to be 1.7 or 1.8 b. A 2nd and 3rd extraction of Pa from the irradiated Th^{234} after 10 and 23 min respectively failed to give any more 23 min activity, indicating that the half-life of the parent $\text{Th}^{235} \ll$ time taken for the initial Pa extraction (12 min). L. R. SHEPHERD

539.163.2
4642. The decay of Mo^{99} and the isomerism of Te^{99} . H. MEDICUS, D. MAEDER AND H. SCHNEIDER. *Helv. Phys. Acta*, **24** (No. 1) 72-88 (1951) *In German*.

A decay scheme is proposed from the measurements. $\sim 87\%$ of the β -decay of Mo leads to an isomeric

state of Tc with energy 1.8 keV. The decay of the isomeric state is followed by the 141 keV, magnetic dipole transition. In the decay of Mo not leading to the isomeric state, γ -rays with energies 728 and 141 keV are emitted in cascade. Two other γ -rays with energies 182 and 360 keV were found. J. HUGHES

539.163.2

4643. Addendum: The disintegration of Ti^{45} . M. TER-POGOSSIAN, C. S. COOK, F. T. PORTER, K. H. MORGANSTERN AND J. HUDIS. Letter in *Phys. Rev.*, **81**, 285 (Jan. 15, 1951). See Abstr. 1997 (1951).

539.163.2

4644. Nuclear recoils resulting from the decay of Be^7 . P. B. SMITH AND J. S. ALLEN. *Phys. Rev.*, **81**, 381-5 (Feb. 1, 1951).

Be^7 was deposited as a thin film on a Ta foil. The energy spectrum of the Li^7 recoils from the reaction $Be^7 + e_k \rightarrow Li^7 + \nu + Q$ was studied. The observed spectra did not exhibit the monoenergetic character predicted by theory. The maximum energy of the recoils was 56.6 ± 1.0 eV, corresponding to a $Be^7 - Li^7$ mass difference of 860 ± 8 keV. This mass difference, in combination with the best value of the $Li^7(p, n)Be^7$ threshold, yields 785 ± 8 keV for $n - H$. Coincidence measurements were made which indicated that monolayer surfaces were probably produced. Auger electrons following the K -capture were observed. The variation of the shape of the recoil energy spectrum was studied as a function of the temperature of the backing foil. A.

539.163.2

4645. Characteristics of Ni^{59} and Ni^{63} . A. R. BROSI, C. J. BORKOWSKI, E. E. CONN AND J. C. GRIESS, JR. *Phys. Rev.*, **81**, 391-5 (Feb. 1, 1951).

Separated stable isotopes of Ni have been used to assign a 67 keV maximum energy beta-emitter which decays with an 85 yr half-life to Ni^{63} . Ni^{59} was found to decay by K electron capture with a half-life of 7.5×10^4 yr. A.

539.163.2

4646. Spontaneous fission in Cm^{242} . G. C. HANNA, B. G. HARVEY, N. MOSS AND P. R. TUNNICLIFFE. Letter in *Phys. Rev.*, **81**, 466-7 (Feb. 1, 1951).

Half-life ($7.2 \pm 0.2 \times 10^6$ yr) and ratio of fragment energies (1.43) determined. W. J. SWIATECKI

539.163.2

4647. The radioactive decay of I^{131} . J. M. CORK, W. C. RUTLEDGE, A. E. STODDARD, C. E. BRANYAN AND W. J. CHILDS. Letter in *Phys. Rev.*, **81**, 482-3 (Feb. 1, 1951).

539.163.2

4648. The disintegration of As^{77} . R. CANADA AND A. C. G. MITCHELL. Letter in *Phys. Rev.*, **81**, 485-6 (Feb. 1, 1951).

539.163.2

4649. Polonium isotopes produced with high energy particles. D. G. KARRAKER AND D. H. TEMPLETON. *Phys. Rev.*, **81**, 510-16 (Feb. 15, 1951).

Investigation of 4 new isotopes of Po produced from Bi and Pb by high energy spallation and their decay products, which include 3 new Pb and Bi activities. The mass assignments are made by the identification of known activities as decay products. A.

539.163.2

4650. Radioactive isotopes of lutetium and hafnium. G. WILKINSON AND H. G. HICKS. *Phys. Rev.*, **81**, 540-3 (Feb. 15, 1951).

A study has been made of neutron-deficient radioactive isotopes of Lu and Hf produced by bombardments of Tm and Yb with alpha-particles of various energies; of Yb with 10 MeV protons, and of Lu with protons of energies from 10 to 70 MeV. Seven radioactive isotopes of Lu and 4 of Hf, all previously unreported, are described. A.

539.163.2

4651. On the isomerism of Kr^{83} and Xe^{133} . I. BERGSTRÖM. Letter in *Phys. Rev.*, **81**, 638-9 (Feb. 15, 1951).

Continuation of Abstr. 6704 (1950) and 581 (1951) with improved technique. Additional electron lines have been found in the Kr^{83} spectrum, 2 of which are interpreted as L and M conversion lines of a 9.3 keV γ -ray; from relative intensity measurements of the electron conversion lines, it appears that this γ -ray is emitted after the known 32.2 keV γ -ray. Tentative conclusions concerning spin of the isomeric and lowest excited states conflict with the spin-orbit nuclear coupling theory. Using the double-focusing spectrometer at 1% resolution, the γ -energy of the Xe^{133} isomeric transition has been found to be 232.8 ± 0.4 keV, the $\frac{1}{2}$ -period being 2.30 ± 0.08 d and $N_K/N_L = 2.90 \pm 0.20$. A decay scheme of I^{133} is proposed. J. C. E. JENNINGS

539.163.2

4652. Radioactivity of Ag^{111} , Cd^{111} , In^{111} , and Sn^{111} . C. L. MCGINNIS. *Phys. Rev.*, **81**, 734-40 (March 1, 1951).

By considering the 111-isobars as a unit it has been possible to specify the spin and parity of the ground states of Ag^{111} , Cd^{111} , In^{111} and Sn^{111} , and of 4 excited states of Cd^{111} . The characteristics of the transitions between these levels are given. The electron spectra associated with $\frac{1}{2}$ hr In^{110} , 4.2 hr In^{109} and 50 min In^{108} are also given. A.

539.163.2

4653. Artificial chains collateral to the heavy radioactive families. W. W. MEINKE, A. GHIORSO AND G. T. SEABORG. *Phys. Rev.*, **81**, 782-98 (March 1, 1951).

A number of heavy alpha-particle emitting nuclides, members of decay chains which are "collateral" to the heavy radioactive series, have been observed and their radioactive properties characterized. Some of these undergo branching decay by orbital electron capture. The parent isotopes are produced in bombardments of thorium with high energy deuterons or He ions in the 184 in cyclotron. Chemical identification has been made in all cases where needed, and the alpha-particle energies have been measured through the use of an alpha-pulse analyser apparatus. The following are the collateral series which have been studied: $Pa^{226} \rightarrow Ac^{222} \rightarrow Fr^{218} \rightarrow At^{214}$ ($4n + 2$ mass type); $Pa^{227} \rightarrow Ac^{223} \rightarrow Fr^{219} \rightarrow At^{215}$ ($4n + 3$); $Pa^{228} \rightarrow Ac^{224} \rightarrow Fr^{220} \rightarrow At^{216}$ ($4n$); $U^{228} \rightarrow Th^{224} \rightarrow Ra^{220} \rightarrow Em^{216}$ ($4n$); $U^{229} \rightarrow Th^{223} \rightarrow Ra^{221} \rightarrow Em^{217}$ ($4n + 1$). A.

539.163.2
4654. Radioactive samarium-145 and promethium-145. F. D. BUTEMENT. Letter in *Nature, Lond.*, **167**, 400 (March 10, 1951).

539.163.2
4655. Radioactivity of astatine isotopes. G. W. BARTON, JR., A. GHIORSO AND I. PERLMAN. *Phys. Rev.*, **82**, 13-19 (April 1, 1951).

A number of new neutron-deficient isotopes of astatine have been identified in the mass-number range 200 to 209 following the irradiation of Bi with high-energy He ions. Their alpha-decay properties fall in line with predictions for isotopes in this region with less than 126 neutrons; that is, the alpha-energies increase with decrease in mass number. Because of the complexity of the isotopic mixtures, half-lives and mass-number assignments were made, in most cases, through the identification of decay products of lower atomic number. The decay properties as now known are summarized.

A.
539.163.2
4656. Interpretation of the decay scheme of K^{40} . P. MORRISON. *Phys. Rev.*, **82**, 209-11 (April 15, 1951).

The 3 ground states and 1 excited state of the 3 nuclei involved in the disintegration of K^{40} are assigned parity and angular momentum values which are essentially unique. The rates of all measured transitions and such energy differences as are well known are used for the assignment, which depends on the $j-j$ coupling shell model, the Gamow-Teller selection rules, and certain empirical groupings of beta-ray lifetimes. Appreciable K -capture directly to the ground state of A^{40} can be excluded on these quasi-theoretical grounds.

A.
539.163.2 : 539.172.13
4657. Products of the high energy helium ion and deuteron bombardment of tungsten. S. E. TURNER AND L. O. MORGAN. Letter in *Phys. Rev.*, **81**, 881-2 (March 1, 1951).

Ta, Re and Os fractions were separated and examined. The presence of 3 Re isotopes was shown, probably Re^{183} ($\frac{1}{2}$ -life 120-140 d), Re^{184} (50 ± 3 d) and Re^{189} (250-300 d).

A. O. STANESBY
539.165
4658. New high- H_p , electron-producing particles in the spectra of β -active radio-elements. J. THIBAUD. *C.R. Acad. Sci., Paris*, **232**, 398-400 (Jan. 29, 1951) In French.

See Abstr. 2969 (1951). Earlier experiments with a magnetic spectrograph have shown that a small fraction of the negative emission from RaC, RaE and P^{32} should be attributed to new particles of $H_p \sim 10^4$ gauss cm, whose disintegration has now been demonstrated. They produce secondary electrons from 50 mg.cm⁻² of Al, more intensely from 50 mg.cm⁻² of Ta, much less from 150 mg.cm⁻² of Ta or 225 mg.cm⁻² of Al. The H_p of the secondaries $\approx$ that of the peak of the β -spectrum, for RaC, RaE and P^{32} . It is suggested that β -decay normally consists of the emission of a particle having a high probability of decaying into an electron in the vicinity of the nucleus. This would explain, among other anomalies, the discrepancy between Wilson chamber and calorimetric estimates of energy from RaE. The

mass of the new particle cannot yet be estimated. Its track in a nuclear emulsion resembles that of a fast electron.

J. C. E. JENNINGS
539.165
4659. Techniques of detecting high momentum negative particles accompanying the β -spectrum. J. THIBAUD. *C.R. Acad. Sci., Paris*, **232**, 495-7 (Feb. 5, 1951) In French.

See preceding Abstr. Diagrams of experimental arrangements are given. Several discrete high H_p values are observed from a given source. Increase in intensity as the photographic film is brought nearer to the source is taken to indicate short life.

J. C. E. JENNINGS
539.165
4660. The beta-spectrum of Tc^{99} . S. I. TAIMUTY. Letter in *Phys. Rev.*, **81**, 461-2 (Feb. 1, 1951).

539.165.2
4661. Window correction curves and the shape of beta-spectra. D. SAXON. Letter in *Phys. Rev.*, **81**, 639 (Feb. 15, 1951).

Gives curves for 0.04 to 2.0 mg.cm⁻² covering H_p between 500 and 2500 gauss cm. Discusses Abstr. 1998 (1951) in their light.

J. C. E. JENNINGS
539.165
4662. The high energy beta-spectrum of Sc^{46} . F. T. PORTER AND C. S. COOK. Letter in *Phys. Rev.*, **81**, 640-1 (Feb. 15, 1951).

This has an end point of 1.2 ± 0.1 MeV. Covering the source with Al of approximately equivalent thickness increased the counting rate by only 15%, instead of 50% expected if electrons had all been Compton electrons from 0.89 and 1.12 MeV γ -rays.

J. C. E. JENNINGS
539.165
4663. Low intensity radiations in I^{131} decay. H. ZELDES, A. R. BROSI AND B. H. KETELLE. Letter in *Phys. Rev.*, **81**, 642 (Feb. 15, 1951).

A beta-group (intensity ~ 0.01) with max. energy 810 ± 5 keV was found, together with K -conversion lines of 2 γ -rays of 635 ± 6 keV (intensity $\sim 4 \times 10^{-4}$) and 720 ± 4 keV ($\sim 1 \times 10^{-4}$); the latter probably a transition to ground-state from the 717 keV level of Xe^{131} .

A. O. STANESBY
539.165 : 518.3/4
4664. A rapid method of calculating log ft values for β -transitions. S. A. MOSZKOWSKI. *Phys. Rev.*, **82**, 35-7 (April 1, 1951).

Contains several graphs and nomographs which make it possible to obtain, very quickly, log ft values for most β -decays. The use of these figures is discussed.

A.
539.165.2
4665. A note on the calculation of the Fermi function in the theory of beta-decay. J. Y. MEI. Letter in *Phys. Rev.*, **81**, 287-8 (Jan. 15, 1951).

539.165.2
4666. The first forbidden shape factor and the $f_{\pi t}$ products for beta-decay. J. P. DAVIDSON, JR. *Phys. Rev.*, **82**, 48-51 (April 1, 1951).

The shape factor used in making Kurie plots for first forbidden beta-decay transitions with maximum

spin change is expressed in a form suitable for computation. Graphs of the function for various Z and W are given. Approximations for the f_{nt} products of beta-decay are derived enabling one to compute these products for certain types of transitions from the values of the allowed f_0 function. Finally, these results are used to compile a table of 1st, 2nd and 3rd forbidden transitions exhibiting the unique spectral shapes associated with maximum spin change for the given degree of forbiddenness. A.

539.165.2

4667. Experiments on the emission of neutrinos from P^{32} . C. W. SHERWIN. *Phys. Rev.*, **82**, 52-7 (April 1, 1951).

These experiments study energy and momentum conservation in beta-decay. The apparatus, improved over earlier experiments, permits increased accuracy in the measurement of the neutrino-electron angular correlation. It is concluded that the correlation is approximately $(1 + \cos \theta)$. Determination of the nature of the dominant interaction in the beta-decay of P^{32} awaits measurement of the nuclear spin. If the spin is one, the tensor interaction is uniquely selected. If the spin is zero, the axial vector dominates. Spin 2 or higher is ruled out by the shape of the beta-spectrum. It is also demonstrated that in beta-decay the missing energy and the missing momentum obey the relation $p = E/c$ to an accuracy of better than 10%. A.

539.165.2 : 539.152.1

4668. On the theory of beta-radioactivity. II. A theoretical discussion of the polarization of electron beams and its observation. H. A. TOLHOEK AND S. R. DE GROOT. *Physica*, **17**, 1-16 (Jan., 1951).

See Abstr. 8963 (1950) for Part I. The state of polarization of electron beams, polarized or unpolarized, can be characterized by a density matrix ρ with two rows and columns

$$\rho = \begin{pmatrix} \rho_{11} & \rho_{12} \\ \rho_{21} & \rho_{22} \end{pmatrix},$$

for a certain pair of fundamental (orthogonal) states (ψ_1, ψ_2) , which serve to characterize the spin orientation. As orientation coefficient with respect to (ψ_1, ψ_2) $P(\psi_1, \psi_2)$ is defined as $\rho_{11} - \rho_{22}$; the degree of polarization is defined as $P = |P(\psi_1, \psi_2)|$ if ρ is in diagonal form for the basis (ψ_1, ψ_2) . It is proved that scattering experiments can give an observation of $P(\psi_1, \psi_2)$ for certain pairs of fundamental states (ψ_1, ψ_2) . In a single-scattering experiment of an entirely polarized beam the intensity ratio of 2 beams in opposite directions is given, obtained after scattering over a right angle by $(1 + a)/(1 - a)$. The intensity ratio of the final beams (in opposite directions) in a double-scattering experiment of an unpolarized beam is written as $(1 + \delta)/(1 - \delta)$. It is shown that the relation $a^2 = \delta$ exists. Further it is found that in order to determine completely the polarization of a beam the determination of 3 independent orientation coefficients is necessary. The polarizations of light and of electron beams have been compared. A.

539.165.2 : 539.152.1

4669. On the theory of beta-radioactivity. III. The influence of electric and magnetic fields on polarized

electron beams. H. A. TOLHOEK AND S. R. DE GROOT. *Physica*, **17**, 17-32 (Jan., 1951).

The influence of electric and magnetic fields on the spin orientation (polarization) of electrons in a beam is calculated according to the Pauli spin theory and the Dirac theory. For the cases, where the field is perpendicular or parallel to a polarized electron beam, the following results are found. Transverse electric field: in the non-relativistic approximation the spin orientation remains constant in space, even if the beam is deflected; the relativistic formula gives for the ratio of the rotation of the spin orientation and the angle of deflection of the beam: E_{kin}/E (ratio of kinetic theory and total energy, i.e. including the rest mass). Transverse magnetic field: the spin orientation does not change in relation to the direction of propagation. Longitudinal electric field: though the beam is accelerated (or retarded) the spin orientation remains constant in space. Longitudinal magnetic field: the spin orientation rotates about the direction of propagation. It is shown that longitudinal polarization of electron beams (spins parallel or antiparallel to the direction of propagation) can be observed by means of an electric deflection of the beam and a scattering experiment in succession. A.

539.165.2 : 539.18

4670. Beta-decay and meson decay. E. R. CAIANIELLO. Letter in *Phys. Rev.*, **81**, 625 (Feb. 15, 1951).

It is shown that Yukawa's scheme of β -decay through the creation of a virtual pseudoscalar π -meson gives an impossibly short lifetime.

W. J. SWIATECKI

539.166

4671. Two crystal spectrometer results with uncollimated γ -rays. J. K. BAIR, F. C. MAIENSCHIEIN AND W. B. BAKER. Letter in *Phys. Rev.*, **81**, 283-4 (Jan. 15, 1951).

539.166

4672. Diffusion of high energy gamma-rays through matter. I. Fundamental equations. L. L. FOLDY. *Phys. Rev.*, **81**, 395-9 (Feb. 1, 1951).

The fundamental processes, photo-electric absorption, Compton scattering and pair production, leading to the modification of the energy spectrum and angular distribution of gamma-rays diffusing through matter are discussed in relation to the problem of penetration of gamma-rays through matter. The transport equation describing the diffusion is derived in the approximation in which radiation from the secondary electrons produced by the photo-electric effect and pair production is neglected. By limiting one's interest to gamma-rays of energy greater than a few MeV, further approximations may be made which reduce the transport equation to a much more simple form. An elementary proof is given for the following theorem: If monoenergetic gamma-rays are incident normally on a slab of material, then after the gamma-rays have undergone many Compton scatterings, the gamma-rays of a given energy are distributed Gaussian-wise in angle about their original direction with the breadth of the distribution being simply related to the energy and increasing with decreasing energy. A.

539.166
4673. Diffusion of high energy gamma-rays through matter. II. Solution of the diffusion equation. L. L. FOLDY AND R. K. OSBORN. *Phys. Rev.*, **81**, 400-4 (Feb. 1, 1951).

An approximate solution of the diffusion equation derived by Foldy has been obtained for the case in which the total gamma-ray cross-section is independent of energy. This is the case for essentially all materials in the energy region in which the derived diffusion equation is valid. For monoenergetic gamma-rays incident normally on a slab of material the distribution in angle of gamma-rays of a given energy after traversing a large thickness of material is shown to be Gaussian with a breadth depending on the energy in accordance with a theorem derived by Foldy. Some numerical calculations for the case of 17 MeV gamma-rays incident on water are presented to illustrate the nature of the results. A.

539.166
4674. Measurements of gamma-ray absorption coefficients. C. M. DAVISSON AND R. D. EVANS. *Phys. Rev.*, **81**, 404-11 (Feb. 1, 1951).

The absorption of γ -rays in Al, Cu, Sn, Ta and Pb was measured using γ -rays from I^{131} , Cu^{64} , Mn^{54} , Co^{60} , Zn^{65} and Na^{24} . Tests showed that scattering from nearby objects and from the absorber were negligible. Tests of the absorption of radium γ -rays in Pb showed good agreement with other workers and with theory. The absorption curves of I^{131} showed a presence of a 0.65 MeV γ -ray about 15% as abundant as the 0.367 MeV γ -ray. Absorption coefficients measured with the other sources showed agreement within 0.5% to 2% with theory. An anomalous absorption coefficient (5% less than expected) with Ta absorber ($Z = 73$) and Zn^{65} and Co^{60} sources ($h\nu \sim 1.2$ MeV) needs reinvestigation. A.

539.166
4675. Transmission of gamma-rays through large thicknesses of heavy materials. G. H. PEEBLES AND AND M. S. PLESSET. *Phys. Rev.*, **81**, 430-9 (Feb. 1, 1951).

A study has been made of the feasibility of accurate numerical determinations of the transmission of gamma-rays through large thicknesses of materials. The first procedure investigated consists in regarding the total probability of photon transmission, N_t , as the sum of the probabilities N_n , where N_n is the probability of photon transmission with exactly n scatterings. The total expected transmitted energy, E_t , is similarly considered to be given by ΣE_n . A numerical calculation of N_n and E_n has been made for $n = 0, 1, 2, 3$ for a slab of U 20 cm thick, upon which photons are incident normally with energy $\alpha = 10 mc^2$. The maximum value of N_n/N_0 occurs at $n = 2$ and of E_n/E_0 at $n = 1$. These calculations are also adapted to a slab of Pb 35 cm thick. Consideration has been given to the behaviour of N_n and E_n for large n , and estimates are thereby made for N_t and E_t . The second procedure consists in deriving the transmission through a thick slab from a succession of transmissions through thin slabs. The transformation of an incident photon distribution into the distribution transmitted through a thin slab is conveniently expressed as a matrix, and the total

transmission is then given by the iteration of the matrix on the successive transmitted distributions. Numerical results obtained by this procedure for particular incident photon distributions are presented. A.

539.166
4676. Gamma-radiation from Pb^{206} . D. E. ALBURGER AND G. FRIEDLANDER. *Phys. Rev.*, **81**, 523-6 (Feb. 15, 1951).

Gamma-rays accompanying the electron-capture decay of 6.4 day Bi^{206} and the alpha-decay of 138 day Po^{210} have been observed by measurement of internal conversion electrons and photo-electrons with a lens spectrometer. The Bi activity showed resolved lines corresponding to gamma-rays of 182, 234, 260, 341, 396, 470, 505, 536, 590, 803, 880, 889, 1 020, 1 097 and 1 720 keV. A thin Po^{210} source of 480 mc alpha-particle strength was found to emit gamma-rays of 800 ± 6 keV energy which yielded K and L internal conversion lines in the ratio of 3.7 ± 0.5 to 1. The 803 keV gamma-ray observed in both the Bi^{206} and Po^{210} activities is identified with a transition from the first excited state of Pb^{206} to the ground state. A.

539.166
4677. The high energy gamma radiation from Ta^{181} . J. M. CORK, W. J. CHILDS, C. E. BRANYAN, W. C. RUTLEDGE AND A. E. STODDARD. Letter in *Phys. Rev.*, **81**, 642-3 (Feb. 15, 1951).

539.166
4678. Matrix elements for octupole radiative transitions. A. P. FRENCH. *Phil. Mag.*, **42**, 263-6 (March, 1951).

The formulae derived by Fierz [Abstr. 6720 (1950)] are limited to cases where $\Delta j = \pm 1$ or $l(l-1)$ (j = total angular momentum, multipole order of radiation = 2). The calculations are here extended to all possible values of Δj for the particular case of octupole radiation.

539.166 : 539.174
4679. On the natural width of the γ -level of Cl^{36*} . B. S. DZHELEPOV. *Dokl. Akad. Nauk, SSSR*, **76** (No. 3) 385-8 (1951) In Russian.

This is calculated from existing published data. The capture cross-section of Cl^{35} for thermal neutrons is taken as 36 barns, giving Cl^{36*} which decays chiefly by γ -emission but may instead emit an α -particle (< 0.1 barn) or a proton (0.169 barn). The proton decay constant $\lambda_p = Ck \exp(-\Pi)$, where $k \exp(-\Pi) \simeq 4 \times 10^{-6}$ is the penetrability of the barrier for a proton and C is a factor. On the basis of the liquid drop model, C is calculated, leading to a width $\Gamma_\gamma = 213$ eV, corresponding to $T_\gamma = 2.4 \times 10^{-16}$ sec, which is of the same order as the periods calculated for Be^8 , B^{10} , N^{13} and N^{14} by Fowler, Lauritsen and Lauritsen [Abstr. 2190 (1948)]. J. C. E. JENNINGS

539.166.2 : 537.542
4680. Scintillation spectra of As^{76} . J. K. BAIR AND F. MAIENSCHNEIN. Letter in *Phys. Rev.*, **81**, 463 (Feb. 1, 1951).

539.166.831
4681. The angular correlation of photo-electrons ejected by annihilation quanta. F. L. HEREFORD. Letter in *Phys. Rev.*, **81**, 482 (Feb. 1, 1951).

Experimental: for discussion see Abstr. following.
A. O. STANESBY

539.166.831
4682. Directional distribution of photo-electrons ejected by polarized quanta. F. L. HEREFORD. Letter in *Phys. Rev.*, **81**, 627-8 (Feb. 15, 1951).

A discussion of results reported in previous Abstr. A relativistic theory by Souter [*Ann. Physik*, **11**, 454 (1931)] fails to explain the asymmetry in the directional distribution of photo-electrons ejected coincidentally by annihilation radiation.

P. T. LANDSBERG

539.166.831
4683. The internal conversion spectrum of the transition ionium $\rightarrow$ radium. S. ROSENBLUM AND M. VALADARES. *C.R. Acad. Sci., Paris*, **232**, 501-3 (Feb. 5, 1951) *In French*.

The β -particles from Io were examined in a semi-circular-focusing, permanent-magnet spectrometer using photographic recording over a period of several days: three of the lines obtained correspond to conversion in the L_1 , M_1 and N_1 shells of a γ -ray of 67.8 keV; the interpretation of a fourth is ambiguous. A very faint line at 125 keV corresponds to K conversion of a γ -ray of 228 keV.

A. O. STANESBY

539.166.831
4684. A study of Cd^{109} in the cloud chamber. B. DREYFUS, J. K. MAJOR AND P. RADVANYI. *C.R. Acad. Sci., Paris*, **232**, 617-18 (Feb. 12, 1951) *In French*.

The internal conversion electrons emitted by Ag^{109*} (produced by K-capture in Cd^{109}) were studied in a Wilson chamber; the results are in general agreement with previous work, but the statistical accuracy achieved was not high (e.g. projected track lengths are given for only 61 tracks).

A. O. STANESBY

539.166.835
4685. Multiple scattering of electron pairs from (Li, p) gamma-rays in photographic emulsions. L. VOYVODIC AND E. PICKUP. Letter in *Phys. Rev.*, **81**, 471-2 (Feb. 1, 1951).

Be^8 gamma-ray energies deduced from measurements on electron pairs produced in Ilford G5 emulsions do not agree with the line spectrum given by Walker and McDaniel [Abstr. 3896 (1948)]. It is suggested that the constant in the small angle scattering formula is too large by about 35%. In addition an apparent asymmetry of the spectrum was detected.

A. C. COATES

539.166.9
4686. Detection of gamma-ray polarization by pair production. G. C. WICK. Letter in *Phys. Rev.*, **81**, 467-8 (Feb. 1, 1951).

Comment on letter by Berlin and Madansky [Abstr. 7483 (1950)].

A. O. STANESBY

NUCLEAR REACTIONS 539.17

539.17
4687. Collisions of high energy nuclear particles with nuclei. B. J. MOYER AND G. F. CHEW. *Amer. J. Phys.*, **19**, 17-26 (Jan., 1951).

The experimental results for n - p and p - p scattering at high energies are described, and a review of the

present status of theoretical interpretation is given. For the scattering of 90 MeV neutrons by protons the angular distribution indicates that only even states of angular momentum are strongly effective. Evidence of the operation of exchange forces is mentioned. In the scattering of 32 MeV protons by protons the angular distribution is appropriate to s -state interaction alone. The 340 MeV p - p results indicate the existence of non-central (tensor) forces in states of odd orbital angular momentum.

A.

539.17 : 530.145
4688. Boundary conditions for the description of nuclear reactions. M. MOSHINSKY. *Phys. Rev.*, **81**, 347-52 (Feb. 1, 1951).

The several stages of the reaction (initial particles, compound nucleus, etc.) are described in their respective configuration spaces; and the state representing the whole system is given by a wave function in Fock space. The wave equations and the boundary conditions are deduced with the help of an analogy to vibration problems. The interaction leading to the nuclear reaction appears as a boundary condition between the different components of the Fock type wave function. A discussion is given of elastic scattering and of two-particle nuclear reactions, showing that the present procedure gives the same dependence of the cross-sections on energy as the Breit-Wigner resonance formula and its generalizations. A sketch is given of the extension of the present ideas to multiple particle reactions. The whole treatment is non-relativistic.

A.

539.17 : 539.18
4689. Report on recent experimental work on the physics of very fast particles. H. MAIER-LEIBNITZ. *Naturwissenschaften*, **38** (No. 1) 6-11 (1951) *In German*.

Presented (opening with a list of 21 of the world's largest accelerators) under the following headings: interactions between elementary particles (angular distributions in p - p and n - p scattering); interaction of fast particles with nuclei ("transparency" of nuclear matter, transmutations, stars, stripping of deuterons, "pick up" of neutrons, spallation, high energy fission); production of π mesons (yield curves); properties of mesons (masses and half-lives of π and μ mesons); neutral mesons (proofs of existence); interaction of π mesons with matter (stars, capture of π^- mesons into Bohr orbits, mass of π^0 meson). About 50 references (mainly 1950) are listed.

W. J. SWIATECKI

539.172
4690. Preparation of carrier-free manganese 52. J. T. BYRNE. Letter in *J. Chem. Phys.*, **19**, 504 (April, 1951).

539.172 : 537.591.8

Nuclear reactions due to cosmic rays. See Abstr. 4514-15

539.172
4691. The gamma-ray spectrum resulting from capture of negative π -mesons in hydrogen and deuterium. W. K. H. PANOFSKY, R. L. AAMODT AND J. HADLEY. *Phys. Rev.*, **81**, 565-74 (Feb. 15, 1951).

π^- mesons produced in an internal W target bombarded by 330 MeV protons in the 184 in cyclotron

are absorbed in a high-pressure H target. The resulting gamma-ray spectrum is analysed outside the shielding of the cyclotron by means of a 30-channel electron-positron pair spectrometer. The principal results are as follows. (1) the gamma-rays result from two competing reactions: $\pi^- + p \rightarrow n + \gamma$ and $\pi^- + p \rightarrow n + \pi^0$; $\pi^0 \rightarrow 2\gamma$. (2) The ratio between the π^0 yield to the single gamma-ray yield is $= 0.94 \pm 0.20$. (3) The mass difference between the π^- meson and the π^0 meson is given by 10.6 ± 2.0 electron masses. (4) The π^- mass is 275.2 ± 2.5 electron masses. The large mass difference between π^- and π^0 precludes the conclusion that the unexpectedly small π^0 to γ ratio is due to the small amount of momentum space available for π^0 emission. It rather indicates that π^0 emission is slowed down by the nature of the coupling of the π^0 field to the nucleons. The experiment has been repeated by substituting D_2 for H_2 in the vessel. The result is that the reaction $\pi^- + D \rightarrow 2n$ and $\pi^- + D \rightarrow 2n + \gamma$ compete in the ratio 2 : 1. The reaction $\pi^- + D \rightarrow 2n + \pi^0$ is absent.

A.

539.172

4692. The capture of π -mesons in deuterium. K. BRUECKNER, R. SERBER AND K. WATSON. *Phys. Rev.*, **81**, 575-8 (Feb. 15, 1951).

Panofsky, Aamodt and Hadley find that the capture of π -mesons in D leads to 2 neutron emission in 70% of the cases, and to 2 neutrons and a γ -ray in the other 30%. The former process is forbidden for capture of scalar mesons from the K shell. A detailed balancing argument, based on the observed cross-section for $2p \rightarrow D + \pi^+$, permits calculation of the non-radiative capture rate from orbits of higher angular momentum. It is shown that this is too small to account for the observation, and the possibility that the meson is a scalar is thus ruled out. This conclusion could only be avoided by postulating the existence of an interaction between meson and nucleons sufficiently large to alter radically the magnitude of the p -wave functions near the nucleons. For pseudoscalar mesons, non-radiative capture from the K shell is permitted, and the ratio of radiative to non-radiative transitions can be related to the ratio of meson photo-production cross-section to the cross-section for $2p \rightarrow D + \pi^+$. The result is compatible with the type of meson-nucleon coupling which might be expected for pseudoscalar mesons, but uncertainties in the measured quantities are too large to permit a sharper conclusion.

A.

539.172

4693. The absorption of slow π^- mesons in deuterium. S. TAMOR. *Phys. Rev.*, **82**, 38-43 (April 1, 1951).

The possible mechanisms for absorption of π^- mesons in D are considered. A phenomenological treatment of the simple "neutron absorption" enables one to calculate the competition between the processes independently of the value of the π^- nucleon coupling constant. It is found that various meson theories for the charged meson lead to markedly different predictions for the fraction of events leading to gamma-ray emission. The results are compared with experiment and lead to the conclusion that the charged meson is either pseudoscalar or pseudovector.

Comparison with the $(\pi^0 : \gamma)$ ratio from the absorption in H indicates that if the charged meson is pseudoscalar the neutral meson is also pseudoscalar.

A.

539.172.11

4694. Angular distributions of neutrons from (α, n) and (d, n) reactions. B. L. COHEN. Letter in *Phys. Rev.*, **81**, 632-3 (Feb. 15, 1951).

Corrections, for the variation of the detector solid angle in the centre of mass system, and for the fraction of the neutrons detected by a threshold detector at various angles, are shown to remove most of the anisotropy in the (α, n) , but not in the (d, n) reaction.

J. HUGHES

539.172.11

4695. Q -values for (α, p) reactions on aluminium and boron by means of photographic emulsions. H. SLÄTIS, E. HJALMAR AND R. CARLSSON. Letter in *Phys. Rev.*, **81**, 641-2 (Feb. 15, 1951).

Photographic emulsions have been used to measure the energies and directions of the different protons produced by the (α, p) reactions, together with the directions of the corresponding alpha particles thus enabling the Q -values to be computed.

A. C. COATES

539.172.11

4696. Simple capture of alpha-particles. W. E. BENNETT, P. A. ROYS AND B. J. TOPPEL. *Phys. Rev.*, **82**, 20-3 (April 1, 1951).

Gamma-rays have been observed from the simple capture of alpha-particles in Li. The gamma-ray energies were too large for simple capture in Li^6 , but not inconsistent with the reaction $Li^7(\alpha, \gamma)B^{11}$. Three resonances were observed at bombarding energies of 0.401, 0.819 and 0.958 MeV. The corresponding excited states in B^{11} are at 8.90, 9.16 and 9.25 MeV. The yields were too small to use thin targets, but the resonances appeared as steps in the thick target yield curve. The slope of the steps was largely of instrumental origin for the first two resonances and suggested a width of about 6 keV for the upper resonance. Among the other light elements, only Be and B yielded gamma-rays when bombarded by 1.4 MeV alpha-particles; but in these cases, the sharp resonances characteristic of simple capture were absent.

A.

539.172.11

4697. Emission of protons from the compound nucleus F^{18} . R. R. ROY. *Phys. Rev.*, **82**, 227-9 (April 15, 1951).

The emission of protons from the reaction $N^{14}(\alpha, p)O^{17}$ was studied by photographic emulsion technique. Two groups of protons were observed, of Q values of about -1.16 MeV and -2.0 MeV for $E_\alpha = 3.6$ MeV and 4.2 MeV. The yield per million incident α -particles has been estimated at 0.348 and 0.409 for the 2 resonance levels, 3.6 MeV and 4.2 MeV, respectively. The angular distribution of protons in the CM system has a maximum at $\theta = 90^\circ$ for the 2 ground states, and, for the excited states, it is isotropic.

A.

539.172.11 : 539.172.13

4698. Thick target fast neutron yield from 15-MeV deuteron and 30-MeV alpha-bombardment. A. J. ALLEN, J. F. NECHAJ, K.-H. SUN AND B. JENNINGS. *Phys. Rev.*, **81**, 536-9 (Feb. 15, 1951).

The total yield and angular distribution of fast neutrons from bombardment of thick targets of pure Be, Al, Ti, Cr, Mn, Co, Cb, Mo, Ag, Cd, Ta, Au, Pb and Bi by 15 MeV deuterons and 30 MeV alpha-particles was measured. These studies were made using the reaction $S^{32}(n, p)P^{32}$ as a threshold detector and also with fission ionization chambers. The total neutron yield per sec. per μ amp of the cyclotron beam, N , was observed to decrease with increase in nuclear charge, Z , of the target according to the approximate empirical equations, $\log N = 10.18 - 0.0234Z$ for deuteron bombardment and $\log N = 9.68 - 0.0234Z$ for alpha. In all cases studied, the angular distribution of fast neutrons from target bombarded by deuterons showed a pronounced peak in the yield in the forward direction. A.

539.172.13/4

4699. High energy nucleon-nucleon scattering experiments at Berkeley. G. F. CHEW AND B. J. MOYER. *Amer. J. Phys.*, **19**, 203-11 (April, 1951).

The experimental results for n - p and p - p scattering at high energies are described, and a review of the present status of theoretical interpretation is given. For the scattering of 900 MeV neutrons by protons the angular distribution indicates that only even states of angular momentum are strongly effective. Evidence of the operation of exchange forces is mentioned. In the scattering of 32 MeV protons by protons the angular distribution is appropriate to s -state interaction alone. The 340 MeV p - p results indicate the existence of non-central (tensor) forces in states of odd orbital angular momentum. A.

539.172.13

4700. Carrier-free radioisotopes from cyclotron targets. XIV. Preparation and isolation of $Bi^{204, 206}$ from lead. J. D. GILE, W. M. GARRISON AND J. G. HAMILTON. Letter in *J. Chem. Phys.*, **19**, 256 (Feb., 1951).

For previous Part see Abstr. 2997 (1951).

539.172.13

4701. Carrier-free radioisotopes from cyclotron targets. XV. Preparation and isolation of Mn^{52} from chromium. H. R. HAYMOND, W. M. GARRISON AND J. G. HAMILTON. Letter in *J. Chem. Phys.*, **19**, 382-3 (March, 1951).

539.172.13

4702. The angular distribution of high energy neutrons from targets bombarded by 330-MeV protons. R. D. MILLER, D. C. SEWELL AND R. W. WRIGHT. *Phys. Rev.*, **81**, 374-8 (Feb. 1, 1951).

The angular distribution of neutrons with energies above 20 MeV produced by bombardment with the 330 MeV proton beam in the 184 in cyclotron of Be, Al, Cu and U targets has been measured with C detectors. The full widths at half-maximum obtained are 54° for Be, 59° for Al and Cu, and 58° for U. Experimental details and the resulting curves are given. A.

539.172.13

4703. The first excited state of Be^7 from the $Li^7(p, n)Be^7$ reaction. H. B. WILLARD AND W. M. PRESTON. Letter in *Phys. Rev.*, **81**, 480-1 (Feb. 1, 1951).

539.172.13

4704. Alpha-particles from the proton bombardment of phosphorus. J. M. FREEMAN AND J. SEED. Letter in *Proc. Phys. Soc., Lond. A*, **64**, 313-14 (March, 1951).

An alpha-particle group of energy about 2.2 MeV was observed from the reaction $P^{31}(p, \alpha)Si^{28}$. Resonances were observed at proton energies 680, 900 and 1 025 keV. The Q -value is 1.85 ± 0.02 MeV.

539.172.13

4705. Relative high energy neutron yields from targets bombarded with protons and deuterons. W. J. KNOX. *Phys. Rev.*, **81**, 687-92 (March 1, 1951).

Relative neutron yields in the forward direction from various target elements bombarded with 340 MeV protons and 190 MeV deuterons have been measured. Bi fission chambers with a threshold of about 50 MeV were used to detect the high-energy neutrons. When a deuteron beam is used, the neutron yields for light elements agree with the values predicted by the deuteron stripping theory. For the heavy elements, the observed values are fitted best by adding a function proportional to Z^2 to the stripping theory values. This can be interpreted as evidence for the production of high-energy neutrons by the electric field disintegration of the deuteron. The neutron yields from the proton beam vary approximately as $(A-Z)^3$ for target elements from C to U. This indicates that the heavy elements are not completely transparent to 340 MeV protons. Be has an anomalous neutron yield 50% higher than that for C. A.

539.172.13

4706. The reaction energies of light nuclei from magnetic analysis. E. N. STRAIT, D. M. VAN PATTEN, W. W. BUECHNER AND A. SPERDUTO. *Phys. Rev.*, **81**, 747-60 (March 1, 1951).

An extensive survey has been made of the reaction energies of ground-state transitions induced by proton and deuteron bombardment of light nuclei. A total of 19 stable nuclei from D through S was investigated, and the Q -values directly measured for 38 different reactions. From these Q -values, the energy releases of a number of other reactions have been computed. The reactions studied include the (p, α) , (d, p) and (d, α) ; and the individual Q -values have been determined to precisions that are between 0.08 and 0.25%. The reaction products were analysed by means of 180-degree focusing in the field of a large annular magnet. The Q -values measured include those of a series of nuclear reactions which directly connect the mass of the alpha-particle with the deuteron mass and O^{16} . From these measurements, the mass of the alpha-particle has been determined as 4.003865 ± 0.000007 amu. A.

539.172.13

4707. Angular distribution of $Li^7(p, \alpha)\alpha$. F. L. TALBOT, A. BUSALA AND G. C. WIEFFENBACH. *Phys. Rev.*, **32**, 1-4 (April 1, 1951).

The angular distribution of the alpha-particles from the reaction $Li^7(p, \alpha)\alpha$ has been investigated

from 0.5 to 1.4 MeV with a photographic emulsion technique. Values of the coefficients of the $\cos^2 \theta$ and $\cos^4 \theta$ terms are given and compared with the results of other observers. A.

539.172.13

4708. Angular yield of deuterons and alphas from the proton bombardment of beryllium. J. A. NEUENDORFFER, D. R. INGLIS and S. S. HANNA. *Phys. Rev.*, **82**, 75–80 (April 1, 1951).

A photographic target chamber incorporating limited magnetic deflection of product particles was used to measure the angular yield of deuterons and alphas from the proton bombardment of Be at energies up to 1 MeV. The angular variation observed is of the form $1 + A_1 \cos \theta + A_2 \cos^2 \theta$, with relatively large values for A_1 indicating strong interference between states of the compound nucleus of opposite parity. The variation of the total cross-sections with energy suggests the presence of a state of the compound nucleus at $E_p = 0.68$ MeV, in addition to the states previously known at $E_p = 0.33$ and 0.94 MeV. Range in emulsion $v.$ energy measurements, for the light nuclei observed in the reaction are also given. A.

539.172.13

4709. Electric excitation and disintegration of nuclei. I. Excitation and disintegration of nuclei by the Coulomb field of positive particles. C. J. MULLIN and E. GUTH. *Phys. Rev.*, **82**, 141–55 (April 15, 1951).

General formulae for the cross-section for the 2^l -pole excitation (or disintegration) of a nucleus by the electric field of a non-relativistic positively charged projectile have been obtained by using the Born approximation; the finite size of the nucleus has been taken into account. For electric dipole and quadrupole excitation a more accurate evaluation has been made in which the initial and final states of the charged projectile are described by the exact Coulomb field wave functions. The cross-section for electric 2^l -pole excitation of a nucleus by the field of a charged projectile is proportional to the corresponding photo-excitation cross-section; the proportionality factor may be interpreted as the number of virtual electric 2^l -pole quanta in the field of the charged projectile. In the electric dipole case, the cross-section for the inelastic scattering of a charged projectile is shown to be proportional to the cross-section for the production of continuous X-rays by deflection of the projectile in a Coulomb field. Thus a relation is established between the virtual quanta representing the Coulomb field of the projectile and the real quanta of the X-ray spectrum corresponding to the scattering process. The theory of electric transitions has been applied, in some detail, in a discussion of two cases in which it seems likely that these transitions play a significant role. These two cases are (1) the inelastic scattering of deuterons and (2) the electric break-up of the deuteron when it "collides" with a target nucleus. A.

539.172.13

4710. Excited states of the mirror nuclei, Li^7 and Be^7 . A. B. BROWN, C. W. SNYDER, W. A. FOWLER and C. C. LAURITSEN. *Phys. Rev.*, **82**, 159–81 (April 15, 1951).

By studying the alpha-particles emitted in the

disintegration of B^{10} by protons it has been shown that there exists an excited state in Be^7 at 434.4 ± 4 keV which corresponds to the well-known first excited state in the mirror nucleus, Li^7 . Measurements on the inelastic scattering of protons in Li^7 yield a value 479.0 ± 1.0 keV for the energy of the Li^{7*} . The existence of these mirror states adds support to the equality of the p - p and n - n interactions exclusive of electrostatic and magnetic forces. The small difference, 45 ± 4 keV, in the excitation energies is larger than 2nd-order electric effects and is believed to be consistent with the order of magnitude of magnetic interactions in nuclei. The splitting of the ground and excited states must arise in some specific property of the nuclear interactions. In connection with the energy determinations, a detailed discussion is given of the precise measurements of the Q -values of nuclear reactions employing high resolution analysers, electrostatic and magnetic, in the determination of particle energies. Experimental determinations of the cross-sections for $\text{B}^{10}(p, \alpha)\text{Be}^7$, $\text{B}^{10}(p, \alpha')\text{Be}^{7*}(\gamma)\text{Be}^7$, $\text{B}^{10}(p, p)\text{Be}^{10}$, $\text{Li}^7(p, p)\text{Li}^7$ and $\text{Li}^7(p, p')\text{Li}^{7*}(\gamma)\text{Li}^7$ are given. A.

539.172.13

4711. Neutron binding energies from (d, p) reactions and nuclear shell structure. J. A. HARVEY. *Phys. Rev.*, **81**, 353–64 (Feb. 1, 1951).

Using 14 MeV deuterons from the M.I.T. cyclotron, proton spectra have been measured for many heavy and medium atomic weight elements. The range of the protons was measured in Al foils by the method of "peaking" with a triple proportional counter. From the Q -value of the ground-state proton group (measured relative to a Q -value of 5.50 MeV for the Al ground-state group), the neutron binding energy of the residual nucleus has been obtained. These values are compared to the maximum gamma-ray energy obtained from thermal neutron capture. A few neutron binding energies have been measured from the (d, t) reaction and are compared with values obtained from the (γ, n) threshold. Several neutron binding energies have been computed from radioactive decay energies and measured neutron binding energies. All neutron binding energies have been compared with the values predicted from the semi-empirical mass formula. A sharp drop in neutron binding energy of about 2.2 MeV occurs at the completion of the closed shell of 126 neutrons. A drop, a little greater than 2 MeV, occurs at 50 neutrons. There is also a decrease in the region of 82 neutrons. There also seems to be a decrease of about 1 MeV in the region of 29 neutrons, but this is not very conclusive. The differential cross-sections of the ground-state peaks from even Z , odd A isotopes at forward angles are much smaller (about a factor of 10) than the differential cross-sections of the ground-state peaks from the same Z but even A isotopes. The ground-state peaks from Sn^{117} and Pb^{207} , however, are about 50% that of the even A isotopes. A.

539.172.13

4712. Angular distributions of (d, p) reactions using 14-MeV deuterons. H. E. GOVE. *Phys. Rev.*, **81**, 364–73 (Feb. 1, 1951).

The angular distribution of (d, p) reactions for a

series of target elements, using 14 MeV deuterons has been investigated. The targets chosen were thin foils of C, Al, Ni, Ag, Ta, Au and Bi. These were bombarded with deuterons from the MIT cyclotron in the centre of a large scattering chamber shielded from the cyclotron by 4 ft of concrete. The emitted protons were detected in a triple proportional counter which could be set at any angle from 15° to 135° to the beam. In all cases the measured intensity of protons per unit solid angle is found to be greater in the forward direction. The ratio of the area under the distributions from 20° to 90° to that between 90° and 140° varies from 1.6 to 13. For a given element this ratio increases with proton energy. In addition, for C and Al, in which individual groups can be resolved, the intensity of protons in a given group, in some cases, exhibits maxima at various angles. In the three elements of highest atomic number the intensity rises from back angles to a maximum at some forward angle and then drops off towards zero degrees. The position of this "turn over" angle appears to increase slowly with atomic number. The general features of the distributions appear to be explainable on a stripping picture rather than that of a compound nucleus. A.

539.172.13

4713. Inelastic scattering of deuterons by C^{12} . K. K. KELLER, J. B. NIEDNER, C. F. WANG AND F. B. SHULL. Letter in *Phys. Rev.*, **81**, 481-2 (Feb. 1, 1951).

539.172.13

4714. Alpha-particle groups from the $N^{14}(d, \alpha)C^{12}$ and $N^{15}(d, \alpha)C^{13}$ reactions. R. MALM AND W. W. BUECHNER. *Phys. Rev.*, **81**, 519-22 (Feb. 15, 1951).

The alpha-particle groups from N^{14} and N^{15} targets bombarded with 1.4 MeV deuterons have been studied using a magnetic spectrometer. The Q -value for the $N^{14}(d, \alpha)C^{12}$ reaction is found to be 13.575 ± 0.012 MeV, and the energies of the excited states observed in C^{12} are 4.438 ± 0.014 and 9.620 ± 0.013 MeV. For the $N^{15}(d, \alpha)C^{13}$ reaction, the Q -value is measured as 7.681 ± 0.006 with excited states in C^{13} at 3.083 ± 0.005 and 3.677 ± 0.005 MeV. A.

539.172.13

4715. The relative probabilities and absolute cross sections of the D-D reactions. K. G. MCNEILL AND J. M. KEYSER. *Phys. Rev.*, **81**, 602-6 (Feb. 15, 1951).

Measurements with a gas target have been made of the relative probabilities and absolute cross-sections of the two possible D-D reactions, by simultaneously counting the He and H nuclei produced by the reactions. The counters were separated from the target by a thin silica window. The ratio of the cross-section of the neutron-producing reaction to that of the proton-producing reaction was found to increase from 0.95 at 120 keV to 1.06 at 250 keV. The "neutron" cross-section was 0.019 barn at 20 keV and 0.038 barn at 250 keV while the "proton" cross-section increased from 0.020 barn at 120 keV to 0.049 barn at 300 keV. The results can be fitted to an expression of the form $\sigma E = \sum a_i P_i$ and the values of the coefficients a_i are given. A.

539.172.13 : 539.153

4716. Energy spectrum of protons produced in the reaction $C^{12}(d, p)C^{13}$, and its relation with the possible excited states of C^{13} . I. W. M. GIBSON AND J. CATALÀ DE ALEMANY. *An. Real Soc. Esp. Fis. y Quím.*, **46A**, 307-16 (Nov.-Dec., 1950) In Spanish.

During work carried out to obtain accurate range-energy relations in C2 emulsions for protons between 6 and 16.3 MeV no evidence was found for the previously reported existence of a C^{13} level at 0.8 MeV. L. PINCHERLE

539.172.13

4717. Energy levels of B^{10} . F. AJZENBERG. *Phys. Rev.*, **82**, 43-7 (April 1, 1951).

The neutron spectrum at 0° and 80° from the $Be^9(d, n)B^{10}$ reaction has been investigated by means of nuclear emulsions. Energy levels of B^{10} at 0.77, 1.79, 2.22, 3.59, 4.79, 5.12, 5.91, 6.11, 6.57 and 6.81 MeV have been observed as have possible levels at 5.58, 5.68 and 6.38 MeV. There is evidence for multiplicities at 5.12 and, possibly, at 6.11 MeV. No neutron groups were observed which would correspond to levels at 1.4 and 2.85 MeV. This result is in disagreement with the picture of equally spaced levels in B^{10} . An attempt is made to explain the results that led to this picture. A.

539.172.13

4718. Energy levels of B^{11} from the $B^{10}(d, p)B^{11*}$ reaction. D. M. VAN PATTTER, W. W. BUECHNER AND A. SPERDUTO. *Phys. Rev.*, **82**, 248-57 (April 15, 1951).

The proton groups from enriched B^{10} bombarded by 1.51 MeV deuterons have been investigated by means of a magnetic spectrograph of high resolution. Eleven proton groups were assigned to the reaction $B^{10}(d, p)B^{11}$, corresponding to the ground state and ten excited states of B^{11} . Five of these excited states have not been previously reported. At 6.8 MeV excitation of B^{11} , a doublet was observed with a level spacing of 50.0 ± 2.0 keV. The range of excitation of B^{11} covered in these experiments was from 0 to 10.2 MeV. A.

539.172.3

4719. Relative photo-fission cross sections of several fissionable materials. J. McELHINNEY AND W. E. OGLE. *Phys. Rev.*, **81**, 342-4 (Feb. 1, 1951).

Relative cross-sections for the photo-fission of several fissionable elements have been measured using a "catcher" method. The results indicate the following cross-sections with respect to $U^{238} : U^{233}$, 2.49; U^{235} , 1.49; Pu^{239} , 2.51; Th^{232} , 0.257; and Io^{230} , 0.847. A.

539.172.3

4720. The resonance photo-fission cross section for U^{238} . W. E. OGLE AND J. McELHINNEY. *Phys. Rev.*, **81**, 344-6 (Feb. 1, 1951).

An attempt has been made to determine the shape of the U^{238} photo-fission cross-section up to a gamma-ray energy of 22 MeV by an analysis of the excitation function obtained by varying the peak energy of the bremsstrahlung from a 22 MeV betatron. A resonance for the photo-fission process is indicated in the region of 15 MeV. A.

539.172.3

4721. Photo-disintegration of copper. P. R. BYERLY, JR AND W. E. STEPHENS. Letter in *Phys. Rev.*, **81**, 473-4 (Feb. 1, 1951).

539.172.3

4722. High energy photo-protons from carbon. D. WALKER. Letter in *Phys. Rev.*, **81**, 634-5 (Feb. 15, 1951).

A collimated beam of γ -rays from a 195 MeV electron synchrotron is allowed to fall on a carbon target. Photo-protons emitted at various directions are observed in Ilford C-2 plates interleaved with Al absorbers. Integral energy spectra and differential cross-sections for the (γ , p) reaction are determined.

L. R. SHEPHERD

539.172.3

4723. Erratum: The cross section for photo-disintegration of the deuteron at low energies. G. R. BISHOP, C. H. COLLIE, H. HALBAN, A. HEDGRAN, K. SIEGBAHN, S. DU TOIT AND R. WILSON. Letter in *Phys. Rev.*, **81**, 644 (Feb. 15, 1951).

See Abstr. 1307 (1951).

539.172.3

4724. Determination of the photo-nuclear cross sections $S^{32}(\gamma, d)P^{30}$, $S^{32}(\gamma, np)P^{30}$, and $P^{31}(\gamma, n)P^{30}$. L. KATZ AND A. S. PENFOLD. *Phys. Rev.*, **81**, 815-19 (March 1, 1951).

The photo-nuclear cross-sections for the gamma-deuteron and gamma-neutron proton, reactions of the parent isotope S^{32} were measured. An attempt was made to discover whether these reactions are sufficiently strong to offer enough competition to the gamma-neutron reaction to account for the shape of the latter cross-section. S samples were irradiated in the photon beam from the University of Saskatchewan's 22 MeV betatron and an activity curve was obtained. The activity curve was analysed to give a cross-section curve that had a peak value at 26 MeV and an indication of the possible existence of another peak at 24 MeV. The observed threshold energy was 19.15 ± 0.20 MeV, a value that is consistent with the calculated value for a gamma-deuteron reaction. The cross-section curve can be interpreted to be the result of a superposition of a gamma-deuteron cross-section and a gamma-neutron proton, cross-section with peak values of 0.7 ± 0.1 and 1.5 ± 0.2 millibarns, respectively. The half-width energy of the combined cross-section curve was roughly 3 MeV. The integrated cross-section gave a value of 4 millibarns-MeV and it is estimated that this value is too low to offer appreciable competition to the gamma-neutron reaction. The gamma-neutron cross-section from the parent isotope P^{31} was also measured. This curve had a threshold at 12.4 ± 0.2 MeV and the peak occurred at 19 MeV. The peak value was 17 ± 2 millibarns and a half-width energy of 7.6 MeV. It is observed that all cross-sections for photo-nuclear disintegrations so far measured in this laboratory show an energy interval of about 6 MeV between threshold and peak. A.

539.172.3

4725. A model for photo-nuclear reactions. L. MARQUEZ. Letter in *Phys. Rev.*, **81**, 897 (March 1, 1951).

The qualitative features of these reactions are

given by a model where the γ -ray is absorbed in a single nucleon process similar to the photo-electric effect for the deuteron.

G. J. KYNCH

539.172.3

4726. A further theoretical contribution to the photodisintegration of H^3 and He^3 . M. VERDE. *Nuovo Cim.*, **8**, 152-8 (March, 1951).

Integral formulae for the two averages $\bar{\sigma} = \int \sigma(E) dE$ and $\bar{E} = 1/\sigma \int E \sigma(E) dE$ in the electrical dipole transition from the ground state H^3 and He^3 are deduced. Some numerical values of $\bar{\sigma}$ are computed for three types of static potentials. See also Abstr. 7499 (1950).

A.

539.172.4

4727. On the scattering of D-D neutrons by atomic nuclei. S. KIKUCHI AND Y. ODA. *Sci. Pap. Osaka Univ.*, No. 9, 10 pp. (1949).

The total cross-sections of the elements up to calcium for D-D neutrons have been measured. These and previous results for D-D neutrons and also for Li-D neutrons seem to show a marked dependence of the total cross-section on the atomic number of the scatterer, that is, after showing the minimum value at O^{16} , the cross-section is large for odd Z and small for even Z. As this tendency does not depend much on the neutron energy, it seems to be reasonable to correlate that with the nuclear types of scattering or compound nuclei taking into account such theoretical results as given by Bardeen and Feenberg.

A.

539.172.4

4728. The determination of the interaction cross-section for fast neutrons by the sphere method. K. LINTNER, H. MOSER AND J. CERNY. *S.B. Öst. Akad. Wiss., Abt. IIa*, **158** (No. 1-5) 123-34 (1950) In German.

Two methods are described to correct the results, obtained by Lintner (see Abstr. following), for the back scattering of the thermal neutrons by the absorbing sphere. A direct calculation of the correction can be made using the known cross-sections, or the absorption can be measured with and without a Cd shell around the sphere. The application and accuracy of the two methods is discussed. J. HUGHES

539.172.4

4729. The interaction of fast neutrons with the heaviest stable nuclei (Bi, Pb, Tl and Hg). K. LINTNER. *S.B. Öst. Akad. Wiss., Abt. IIa*, **158** (No. 1-5) 135-68 (1950) In German.

The cross-section is obtained from the decrease in the thermal neutron density in a tank of water containing a fast neutron source, when the source is surrounded by a sphere of the material. The (n , $2n$) cross-section is measured by using two sources, the maximum neutron energy of one being too low to excite the reaction. Two methods are used to correct for the back scattering of thermal neutrons by the sphere (see preceding Abstr.). The relative cross-sections for the (n , p), (n , α) and (n , γ) processes are determined by activation measurements. The results obtained are compared with the cross-sections calculated from the statistical theory of nuclear reactions.

J. HUGHES

539.172.4

4730. On the determination of effective cross-sections for thermal neutrons. G. GUÉBEN. *Bull. Soc. Roy. Sci. Liège*, **19**, 525–38 (Dec., 1950) In French.

The experimental technique described in Abstr. 3795 (1951) is used to measure the cross-sections for Pb, Zn, Cu, Ni, Mn, S, P, U, Rh, Ag, Au, Ir. The results are compared with those from 28 other sources in the literature. The reasons for the great dispersion in the various determinations (sometimes an order of magnitude) are discussed.

W. J. SWIATECKI

539.172.4

4731. Some (n, γ) effects in iodobenzene. P. F. D. SHAW. *J. Chem. Soc.* (1951) 443–7 (Feb.).

Some of the factors affecting the reproducibility of extractions (by an aqueous reagent) of radio-iodine from neutron-irradiated iodobenzene have been studied. In the presence of I extractions are easily reproducible, but without I the amount of extractable radio-iodine is variable because of the variable formation of aliphatic radio-iodine compounds which are probably produced by the "rupture" of benzene rings by the energetic recoiling radio-iodine atoms. The low value (about 40%) for the efficiency of extraction of radio-iodine from iodobenzene compared with that for other organic monohalides is probably caused by the formation of a stabilized "iodonium" radical, Ph_2I^- .

A.

539.172.4

4732. The existence of different capture levels in the formation of nuclear isomers by slow neutron irradiation. P. C. CAPRON AND A. J. VERHOEVE-STOKKINK. *Phys. Rev.*, **81**, 336–9 (Feb. 1, 1951).

Experiments have been performed on the formation of Br and Rh isomers, by thermal as well as resonance neutrons, in order to study capture levels. With slow neutrons of variable energies obtained from a Ra-Be source in a slowing-down medium of paraffin, were studied: (a) the relative formation of the isomeric pairs as a function of the distance from the source and (b) the migration distances for each isomer. The experimental results show that for Br isomers produced by resonance neutrons as well as for Rh isomers produced by resonance and C-neutrons, the ratio of the activities of the fundamental state to the metastable state is a function of the distance from the source. Moreover, at each point this ratio is different for resonance and for C-neutrons. The migration distances corresponding to each of the isomers formed by resonance neutrons on Br, or by C-neutrons on Rh, are found to be different. This leads to the assumption of the existence of more than one capture level in the formation of the Br and Rh isomers. It may be suggested that for Rh the resonance levels extend within the region defined by the C-neutrons.

A.

539.172.4

4733. The cross section ratio $\sigma[\text{B}^{10}(n, \alpha)\text{Li}^7]/\sigma[\text{B}^{10}(n, \alpha)\text{Li}^{7*}]$ as a function of energy. H. BICHSEL, W. HÄLG, P. HUBER AND A. STEBLER. Letter in *Phys. Rev.*, **81**, 456–7 (Feb. 1, 1951).

539.172.4

4734. The $\text{Li}^6(n, \alpha)\text{H}^3$ reaction spectrum. U. FACCHINI, E. GATTI AND E. GERMAGNOLI. Letter in *Phys. Rev.*, **81**, 475–6 (Feb. 1); **82**, 555 (May, 1951).

539.172.4

4735. The neutron capture cross section of Am^{241} . G. C. HANNA, B. G. HARVEY AND N. MOSS. Letter in *Phys. Rev.*, **81**, 486–7 (Feb. 1, 1951).

539.172.4

4736. Odd-even effect in neutron capture gamma-ray spectra. B. HAMERMESH. Letter in *Phys. Rev.*, **81**, 487 (Feb. 1, 1951).

539.172.4

4737. Coherent scattering amplitudes as determined by neutron diffraction. C. G. SHULL AND E. O. WOLLAN. *Phys. Rev.*, **81**, 527–35 (Feb. 15, 1951).

The coherent scattering properties of nearly 60 elements or nuclides for slow neutrons have been determined by neutron diffraction techniques and are summarized in the present paper. The phase of scattering and values for the coherent scattering amplitude and cross-section and for the total scattering cross-section are given. Pronounced differences in isotopic scattering properties have been found and many nuclides are shown to possess strong spin-dependent scattering properties. Illustrations of thermal diffuse scattering and nuclear spin incoherent scattering are given.

A.

539.172.4

4738. The energy spectrum of particles emitted in the reaction ${}^3\text{Li}(n, \alpha){}^3\text{H}$. U. FACCHINI, E. GATTI AND E. GERMAGNOLI. *Nuovo Cim.*, **8**, 145–51 (March, 1951).

This has been determined by means of a gridded ionization chamber. The following values, corrected for energy losses in the emitting layers, have been obtained for the energies of α and H^3 particles: $E_\alpha = 2.059 \pm 0.010$ MeV, $E_{\text{H}^3} = 2.745 \pm 0.013$ MeV. These values agree with known range values of the same particles, if Jesse and Sadauskis range-energy curves are used for the comparison.

A.

539.172.4

4739. The fast neutron disintegration of C^{12} and B^{10} . J. L. PERKIN. Letter in *Phys. Rev.*, **81**, 892–3 (March 1, 1951).

An analysis of 700 stars obtained using 2–24 MeV neutrons [similar to L. L. Green, W. M. Gibson, Abstr. 3445 (1949)] gives information about excited states of Be^8 .

W. J. SWIATECKI

539.172.4

4740. Activation cross sections measured with antimony-beryllium photo-neutrons. V. HUMMEL AND B. HAMERMESH. *Phys. Rev.*, **82**, 67–8 (April 1, 1951).

Activation cross-sections for 15 isotopes have been measured by means of an Sb-Be photo-neutron source. The cross-sections have been determined relative to the values of the thermal neutron activation cross-sections of each substance.

A.

539.172.4

4741. The inelastic scattering of 15-MeV neutrons by lead, iron and aluminum. P. H. STELSON AND C. GOODMAN. *Phys. Rev.*, **82**, 69–71 (April 1, 1951).

A T-Zr target bombarded by 1.0 MeV deuterons from the Rockefeller electrostatic generator was used as a source of high energy (~ 15 MeV) neutrons. This source was surrounded by Pb, Fe and Al scatterers with dimensions of approximately one mean free path for inelastic scattering. The resulting

neutron spectra were measured by means of proton recoils in photographic emulsions. An exposure without scatterer permitted an evaluation of the upper limit for the neutron background. The spectra indicate that most of the neutrons are inelastically scattered to energies below 3 MeV in the case of the Pb and Fe scatterers and to below 5 MeV with the Al scatterer. The data can be represented by a curve of the form (const. $Ee^{-E/T}$) as predicted by the Weisskopf statistical theory. The values obtained for the nuclear temperatures, T , are 0.7, 0.6 and 1.1 MeV for Pb, Fe and Al, respectively. The fact that the measured temperatures for Fe and Pb are approximately the same supports the hypothesis that Pb nuclei have a closed shell structure and therefore have properties similar to much lighter nuclei.

539.172.4

4742. Neutron-proton scattering at 27 MeV. J. E. BROLLEY, JR., J. H. COON AND J. L. FOWLER. *Phys. Rev.*, **82**, 190–3 (April 15, 1951).

Monoenergetic neutrons of energy 27.2 MeV were produced by 10 MeV deuterons incident on a gaseous T target. Protons recoiling from the neutrons were observed in a fourfold coincidence proportional counter telescope. The angular distribution of neutrons scattered through angles in the range from 180° to 76° in the CM system was measured. The observed ratio of scattering at 180° to that at 90° was 1.28 ± 0.10 .

539.172.4

4743. Relativistic corrections in high energy n - p scattering. A. SIEGEL. *Phys. Rev.*, **82**, 194–203 (April 15, 1951).

A method, due to Breit, of generalizing phenomenological nuclear interactions to give a relativistically invariant cross-section in the first Born approximation, has been extended to apply to a broad class of non-relativistic interactions; namely, those containing isotopic spin operators and any kind of Pauli spin and space dependence. A procedure is given for obtaining an equivalent Pauli operator for the Dirac operators so obtained, which reduces the calculation of the relativistic cross-section (in the first Born approximation), formally, to a non-relativistic calculation. The cross-section is then obtained in a form in which the relativistic corrections are explicitly split off from the non-relativistic terms. The method is applied to the symmetric exchange interaction with tensor forces. The form of the relativistic interaction is not uniquely determined by that of the non-relativistic one, but a number of the more conservative possibilities are investigated. The corrections to the 90 MeV n - p scattering thus obtained are analysed in relation to the data. The possibility of exploiting these corrections to adjust the theory to experiment is discussed.

539.172.4

4744. Gleep: design, construction and use. F. C. W. COLMER AND D. J. LITTLER. *Nucleonics*, **8**, 3–12 (Jan., 1951).

Gleep is a graphite-moderated natural U reactor having the form of a right octagonal prism lying

on one side, with a cylindrical core 5.24 m in length and 2.86 m radius. Twelve tons of U metal in the form of Al-sprayed rods 12 in long by 0.9 in dia. are loaded in the central region of the core and 21 tons of dioxide, pressed into pellets 1.6 in dia. and canned in Al are loaded in the outer channels. There is a 5 ft square 7 ft long graphite thermal column, extending through the concrete shield on one side. Limited air cooling is provided and allows a maximum power of 100 kW. Five Cd control rods and 6 Cd shut-off rods are provided, the reproduction constant (κ) of the pile with these fully removed is 1.002. Resistance thermometers measure graphite and U-rod temperatures, and a shut-down occurs if the maximum recorded U surface temperature exceeds 60°C. Seven experimental channels through the reactor are provided and a maximum flux of 3.0×10^{10} n/cm²/sec is available at 100 kW. A mechanical oscillator is installed for swinging samples in the pile in order to determine thermal neutron cross-sections (by observing the magnitude of the modulation of pile power). The use of a temperature-controlled wire-wound resistance of 10^8 ohms in series with the BF₃ chambers has made it possible to hold the neutron density at very accurately reproducible levels and hence to provide standard fluxes in the range 10^6 – 10^8 n/cm²/sec.

L. R. SHEPHERD

539.172.4

4745. Nuclear data for low-power reactors. *Nucleonics*, **8**, 78 (Jan., 1951).

Data relating to the design and operation of low-power reactors have recently been declassified. The following thermal neutron cross-sections for fission, radiative capture and scattering are given: $\sigma_f(U^{235}) = 545$ b; $\sigma_r(U^{235}) = 100$ b, $\sigma_s(U^{235}) = 8.2$ b, $\sigma_f(U^{238}) = 0$, $\sigma_r(U^{238}) = 2.6$ b, $\sigma_s(U^{238}) = 8.2$ b. A graph of σ_f of natural U between 0.7 MeV and 5 MeV is given, this is nearly zero below 1 MeV and rises to 0.65 b at 5 MeV. The number of neutrons released per thermal neutron fission in U²³⁵ is 2.5 ± 0.1 and these have an approximate energy distribution of $\{\sinh \sqrt{(2E)}\} \exp(-E)$ where E is in MeV. The resonance absorption integral for natural U in a flux of neutrons slowing down from fission energy to thermal energy, is given by an empirical formula $[\sigma_r(E)dE/E = 9.25[1 + 2.67(S/M)]]$ where S/M is the ratio of surface area to mass of metal in cm²/gm.

L. R. SHEPHERD

539.172.4

4746. Fission in Am²⁴². G. C. HANNA, B. G. HARVEY, N. MOSS AND P. R. TUNNICLIFFE. Letter in *Phys. Rev.*, **81**, 893–4 (March 1, 1951).

Cross-sections for slow neutron capture (5 500 barns) and fission (2 500 barns) for Am²⁴² were obtained.

W. J. SWIATECKI

539.174

4747. The excitation energy difference in Li⁷-Be⁷. E. FEENBERG. Letter in *Phys. Rev.*, **81**, 644 (Feb. 15, 1951).

A discrepancy with respect to other "mirror nuclei" in the Coulomb energy difference is explained in terms of the expansion of the nuclei under electrostatic forces.

W. J. SWIATECKI

ATOM AND MOLECULE BEAMS . MESONS NEUTRONS 539.18

539.18
4748. The production of π -mesons in proton-proton collisions. J. G. GUNN, E. A. POWER AND B. TOUSCHEK. Letter in *Phys. Rev.*, **81**, 277-8 (Jan. 15, 1951).

539.18
4749. Low energy electron resulting from a stopped μ -meson. G. GROETZINGER, L. B. LEDER AND F. L. RIBE. Letter in *Phys. Rev.*, **81**, 626 (Feb. 15, 1951).

A single event of a 70 keV electron observed in 10 000 expansions of a cloud chamber.

W. J. SWIATECKI

539.18
4750. Experimental search for the beta-decay of the π^+ meson. H. L. FRIEDMAN AND J. RAINWATER. Letter in *Phys. Rev.*, **81**, 644-5 (Feb. 15, 1951).

By photographic plate method and using 11 to 14 MeV mesons from 164 in cyclotron gave: zero ($\pi - e$) events compared to 829 ($\pi - \mu$) events.

W. J. SWIATECKI

539.18
4751. Angular distribution of the pions produced in high energy nuclear collisions. E. FERMI. *Phys. Rev.*, **81**, 683-7 (March 1, 1951).

The angular distribution of π -mesons produced in a high energy collision of two nucleons is discussed in terms of the statistical theory of multiple meson production. The results are compared with experimental findings.

A.

539.18
4752. Detection of positive π -mesons by π^+ decay. M. JAKOBSON, A. SCHULZ AND J. STEINBERGER. Letter in *Phys. Rev.*, **81**, 894-5 (March 1, 1951).

Delayed coincidence counts in scintillation detectors give for the mean life: $2.54 \pm 0.11 \times 10^{-8}$ sec.

E. P. GEORGE

539.18
4753. On the branching ratio of the π^+ meson. F. M. SMITH. Letter in *Phys. Rev.*, **81**, 897-8 (March 1, 1951).

The fraction of π^+ mesons which do not decay into μ^+ mesons at end of range in photographic emulsions (Ilford G₅, Eastman NTB₂) found to be $0.3 \pm 0.4\%$.

W. J. SWIATECKI

539.18
4754. Photo-production of neutral mesons in nuclear electric fields and the mean life of the neutral meson. H. PRIMAKOFF. Letter in *Phys. Rev.*, **81**, 899 (March 1, 1951).

539.18 : 537.591

4755. On the production of mesons by primary cosmic rays. H. D. RATHGEER. *Phys. Rev.*, **81**, 544-51 (Feb. 15, 1951).

The present ideas on the production of π -mesons by the primary cosmic-rays and of their decay into μ -mesons lead to differences between the calculated and observed intensities, total energies of the components and geomagnetic effects, which do not appear resolvable by any plausible adjustment. A consistent

explanation of the several effects is found in the assumption of a further intermediate meson, which is identified with the τ -meson of about 900 electron masses. A model which agrees with the available data and is not contradicted by the facts of direct observation, such as in photographic emulsions, consists in the following assumptions: production of τ -mesons and π -mesons in a ratio of 5 to 1 by the primary nucleons with a multiplicity $2.7 P^{0.5}$ (P in BeV/c); decay of the τ -mesons into π -mesons with a mean life of 10^{-10} sec; decay of the π -mesons into μ -mesons.

A.

539.18 : 537.591.15

4756. An experiment on the anomalous scattering of μ -mesons by nucleons. E. AMALDI AND G. FIDECARO. *Phys. Rev.*, **81**, 339-41 (Feb. 1, 1951).

Large angle scattering of fast μ -mesons by an iron plate, 6 cm thick, has been investigated by means of a counter-hodoscope which recorded separately 2 energy bands: from 200 MeV to 320 MeV kinetic energy, and from 320 MeV to infinity. About half a million incident μ -mesons were counted. Upper limits for the cross-sections for anomalous scattering were obtained: about 4.5×10^{-29} cm²/nucleon for the low energy band; about 2.3×10^{-30} cm²/nucleon for the high energy band. Also an upper limit for the cross-section for production of penetrating showers by μ -mesons at sea level is given. We found a cross-section of 10^{-30} cm²/nucleon for showers of at least 2 particles of which at least 1 is emitted at an angle larger than 20° with a range of at least 7 cm Fe + 5 cm Pb.

A.

539.18 : 539.174.3

4757. On the production of mesons by photons. J. SERPE. *Physica*, **16**, 890-4 (Dec., 1950).

The production of π -mesons in collisions between photons and nuclei is investigated, the nuclei being considered as a Fermi gas at 0°K. The conclusions, which, in the approximation adopted, are valid for all types of meson theory, are compared with recent experimental results [Abstr. 6736 (1950)].

A.

539.181 : 535.23.08

4758. Use of a low temperature bolometer for detecting a beam of free radicals. C. A. REILLY AND B. S. RABINOVITCH. *J. Chem. Phys.*, **19**, 248-9 (Feb., 1951).

539.185

4759. The diffusion of thermal neutrons. (Exact theory taking account of the anisotropy of single scattering.) D. LYONS. *Ann. Phys., Lpz.*, **8** (No. 3-4) 156-75 (1950) *In German*.

The linear albedo problem is solved, for a point neutron source in an infinite medium, and for an absorbing layer in an infinite medium, with neutrons passing through the plate. Exact and approximate solutions are given.

J. HUGHES

539.185

4760. On the space energy distribution of slowed-down neutrons. G. HOLTE. *Ark. Fys.*, **2**, Paper 48, 523-49 (1951).

This has been studied for an infinite, homogeneous slowing-down medium. The neutrons are emitted isotropically with constant energy E_0 from

a point source. The mean free path λ is assumed constant for energies below E_0 (this is a good approximation in general only for $E_0 \leq 0.1$ MeV, but the formulae are also useful for higher E_0). For neutrons of energy E at distance R from the source (putting $\lambda = 1$) the number of collisions per unit volume per unit energy range is $F_0(R, E) = Q/Ex^{3/2} \mu e^{-\nu R}$, where Q is the number of neutrons emitted per unit time, $x = \log E_0/E$ and ν and μ are functions of R/x . Analytic expressions have been calculated for these functions. Applications are made to deuterium and carbon.

W. J. SWIATECKI

539.185

4761. Comparison of weak neutron fluxes by use of organic bromides. P. F. D. SHAW AND C. H. COLLIE. *J. Chem. Soc.* (1951) 434-43 (Feb.).

A quantitative study has been made of some of the factors influencing the reproducibility of extractions (using an aqueous extracting agent) of radio-bromine from neutron-irradiated ethyl bromide, bromobenzene, and ethylene dibromide. The chief cause of non-reproducibility of extractions of these substances is the presence of olefinic impurities produced by the recoiling radio-bromine atoms. By irradiating specimens containing a trace of elementary Br, and by making corrections when necessary for exchange between the extractable radioactive species and the bulk of the (inactive) liquid, extractions can be made reproducible to better than $\pm 1\%$. Aniline present during the neutron-irradiation of ethylene dibromide reduces the amount of radio-bromine extractable with KBr, owing to the formation of bromoaniline, but at the same time reduces the exchange occurring in the pure liquid, and if present in sufficient quantity, increases the amount of extractable radio-bromine by playing a direct part in the γ -recoil process.

A.

539.185

4762. 90-MeV neutron-proton scattering at large proton angles. R. WALLACE. *Phys. Rev.*, **81**, 493-7 (Feb. 15, 1951).

Neutron-proton scattering with 90 MeV neutrons has been investigated by others, using a proportional counter technique and also using a cloud chamber, and the scattering cross-section for neutrons for centre-of-mass angles from 36° to 180° has been measured. The present experiment was an attempt to overlap the data of Hadley *et al.*, from 74° to 36° and to extend the cross-section measurements to smaller angles. This experiment was performed with nuclear emulsions in order to permit the detection of protons down to about 1.5 MeV, and to avoid systematic errors which might be present in the case of other methods of detection. The results agree with those of Hadley *et al.*, within the probable error, and the cross-section curve exhibits beyond 36° the same general trend as does their curve.

A.

539.185

4763. Reflection of neutrons from magnetized mirrors. D. J. HUGHES AND M. T. BURG. *Phys. Rev.*, **81**, 498-506 (Feb. 15, 1951).

The index of refraction for neutrons in ferromagnetic materials has been studied by total reflection from mirrors. It is shown that Bloch's constant, C ,

is unity; i.e. that the effective field for neutrons in a ferromagnet is $\mathbf{B}$. For the case of total reflection, it is found that the magnetic part of the index is given by the field averaged over a region large compared to the size of the magnetic domains. Completely polarized thermal neutrons have been produced, without the necessity of monochromatization, by reflection from magnetized Co. Measurement of the polarization, performed by reflection at a second Co mirror, requires careful elimination of reorientation effects in the region between the mirrors.

A.

539.185

4764. Production of highly polarized neutron beams by Bragg reflection from ferromagnetic crystals. C. G. SHULL. Letter in *Phys. Rev.*, **81**, 626 (Feb. 15, 1951).

A highly polarized beam of neutrons is obtained by crystal reflection from Fe_3O_4 , for which the nuclear and magnetic scattering amplitudes are very nearly equal. Comparison with the scattering by Fe shows directly that Fe_3O_4 is antiferromagnetic.

J. THEWLIS

539.185

4765. Neutron-deuteron scattering at high energy. R. L. GLUCKSTERN AND H. A. BETHE. *Phys. Rev.*, **81**, 761-81 (March 1, 1951).

The neutron-deuteron total scattering cross-section at high energy has been calculated by expressing it as a sum over two-particle states over a wide range of energy. A sum rule was then applied to give the total cross-section, that is, the elastic and inelastic cross-sections. The calculations were performed with a Serber type exchange force for the neutron-proton force in agreement with present neutron-proton scattering data and a neutron-neutron force of arbitrary depth and exchange character. The neutron-neutron well depth was then determined for an ordinary, Serber type and pure exchange force between the two neutrons by making use of the experimental neutron-deuteron total cross-section. The neutron-deuteron elastic scattering was then calculated for the 3 different types of neutron-neutron exchange and was found to agree best with the experimental value for the Serber type exchange (no force in odd states). The cross-section for production of low-energy protons was also calculated and confirmed the Serber type exchange force between the two neutrons when compared with the experimental value. Finally, a qualitative discussion of the angular and energy distribution of the low and high energy protons was given.

A.

539.185

4766. The Harwell time-of-flight neutron spectrometer. A. W. MERRISON AND E. R. WIBLIN. *Nature, Lond.*, **167**, 346-7 (March 3, 1951).

Details of the complete installation are briefly described, including the accelerator, control mechanism, vacuum system and time-of-flight measuring circuits. It works at 3.5 MeV and operates as a source of pulsed neutrons and is arranged to cover the energy region 10 eV-20 keV, but is limited by the accelerator at present available to energies up to about 1 keV. Details of the resolution and counting-rate are given.

J. THEWLIS

539.185

4767. Emission of slow neutrons by a radium-beryllium source. E. GIEGERL AND E. BRODA. Letter in *Nature, Lond.*, **167**, 399–400 (March 10, 1951).

The emission of slow neutrons having energies within the resonance bands of Dy, In and I was estimated by activation measurements. The numbers of such neutrons emitted per second per mC per eV of the resonance band were 1.5, 1.2 and 1.0 respectively.

J. THEWLIS

539.185

4768. Neutron depolarization on scattering from carbon, paraffin, and phosphorus. W. E. MEYERHOF AND D. B. NICODEMUS. *Phys. Rev.*, **82**, 5–12 (April, 1951).

The depolarization of polarized thermal neutrons scattered from C, paraffin and P has been measured. The results have been interpreted in terms of the spin flip probability on scattering, which for C was found to be equal to -0.09 ± 0.21 and for H 0.56 ± 0.10 , consistent with the theoretically expected values 0 and 0.65, respectively. For P, the measured spin flip probability of 0.73 ± 0.15 yields an incoherent scattering cross-section of 3.7 ± 0.8 b, of the same order of magnitude as the total scattering cross-section (3.4 b). This would imply one or more s-neutron resonance levels in P above 400 eV, the present upper limit of the well-investigated part of the total neutron cross-section of P.

A.

539.185.7

4769. On the slowing down of neutrons. C. C. GROSJEAN. *Meded. K. Vlaamse Acad. Wetensch., Belg.*, **11** (No. 13) 59 pp. (1949).

Energy distributions are calculated by more direct methods than the Laplace transformation method used by Marshak [Abstr. 193 (1948)]. The probabilities of the various events possible, scattering, capture, etc., are written down and the whole expression integrated, using the boundary conditions. Marshak's notation is used in order to facilitate a comparison of the results obtained. Spatial distributions for infinite media containing heavy nuclei are also calculated.

J. HUGHES

STRUCTURE OF SOLIDS 539.2

539.21 : 537.312.5

Exciton-enhanced photoelectric emission from F-centers in RbI near 85°K. See Abstr. 4391

539.21 : 537.312.5

Mechanism of exciton-enhanced photoelectric emission in alkali halides. See Abstr. 4392

539.21 : 669

4770. The AEC in solid-state metallurgy. D. W. LILLIE. *Nucleonics*, **8**, 17–23 (Jan., 1951).

Basic research programmes carried out extramurally for the A.E.C. are outlined. These include studies of creep in alloys, self-diffusion, grain boundary energies, diffusion at grain boundaries,

lattice imperfections, nature of solid solutions and phenomena involved in the sintering process.

L. R. SHEPHERD

539.217

4771. Solid solutions of the alkali halides. II. The theoretical calculation of lattice constants, heats of mixing, and distributions between solid and aqueous phases. G. S. DURHAM AND J. A. HAWKINS. *J. Chem. Phys.*, **19**, 149–56 (Feb., 1951).

It is assumed that the ions are not at a constant nearest-neighbour distance, but take up positions of minimum potential energy relative to one another. A method making use of the Born–Mayer–Huggins equation for the lattice energies of the alkali halides is developed for the determination of these positions in a simplified model and for the calculation of the potential energy associated with the resultant lattice. From these values, the average lattice constant, the heat of mixing, and the activity-coefficient ratio in the solid solution are calculated; from the latter is obtained the theoretical distribution ratio between solid and aqueous solutions. Values of the listed properties have been calculated at various mole fractions for the solid solutions KBr–KCl, RbBr–RbCl, RbCl–KCl, RbBr–KBr at 25° and have been found to be in good agreement with the experimental data available.

A.

539.217

4772. The diffusion of thoron atoms through photographic gelatin. G. G. EICHHOLZ AND F. C. FLACK. *J. Chem. Phys.*, **19**, 363–6 (March, 1951).

Observations have been carried out on the splitting of Th stars in photographic emulsions. It is found that this process is caused entirely by the Brownian motion of the thoron atoms produced in the course of successive decays. Applying the classical statistical theory, the diffusion coefficient of thoron in gelatin and the viscosity of dry gelatin at room temperature have been deduced. The results are discussed in the light of our present knowledge of the structure of gelatin.

A.

539.217

4773. Theory of D_0 for atomic diffusion in metals. C. ZENER. *J. Appl. Phys.*, **22**, 372–5 (April, 1951).

The theory of the entropy of activation ΔS previously given for interstitial diffusion in metals is herein extended to self- and to chemical diffusion. It is concluded that this entropy of activation will always be positive; and it is shown that in the case of self-diffusion and of chemical diffusion at very low concentrations, the better the empirical ΔS the better does it correlate with the theoretical positive ΔS . The large negative apparent ΔS frequently found for chemical diffusion at higher concentrations must be attributed either to inaccuracies in experiments or to the presence of short-circuiting diffusion paths. It is predicted that the presently reported negative values of ΔS will become positive when very small concentrations are used in large grain-size specimens.

A.

539.217 : 538.221

Precipitation and the domain structure of alnico 5. See Abstr. 4527

539.217 : 539.16.08

4774. Self-diffusion in cobalt. F. C. NIX AND F. E. JAUMOT, JR. *Phys. Rev.*, **82**, 72-4 (April 1, 1951).

The self-diffusion of Co has been measured using radioactive Co^{60} . The radioactive Co^{60} was evaporated on to the surface of pure Co samples. The absorption coefficient in Co of the complex spectrum of the radioactive isotope was required in the mathematical analysis used. This was determined under conditions similar to those present in the diffusion samples. The data at 1 050°C, 1 150°C and 1 250°C, indicate that the self-diffusion coefficient for Co is given approximately by $D = 0.37e^{-67000/RT} \text{ cm}^2\text{-sec}^{-1}$.

A.

539.217 : 548.0

4775. Diffusion in crystalline silicates. I. J. ROSENQVIST. *Forsvarets ForsknInst. Arb.*, **2**, 342-62 (1948-49) In Norwegian.

Previous investigations are briefly reviewed and the use of radioactive indicators is discussed. The experiments reported are based on the assumptions that the diffusion coefficients for radioactive ions are much greater in glass than in crystals, that the penetration of the ions is much less than that of β - and γ -rays, and that the thermodynamic activity at equal concentrations is the same in glass and crystal phase. The third assumption proved not true and corrections were subsequently made. Glass drops containing RaD were melted on to polished surfaces of felspar crystals which were then heated until a penetration of 0.2-0.3 mm could be expected. The drops were removed and the radioactivity of successive layers removed from the crystal was measured. The theory of the process is developed and the experimental procedure is described in detail. Sodium and potassium felspar were used. The results are tabulated, showing an average value of 2.5×10^{-6} for the coefficient. In microline pertite a slight anisotropy was found at the high temperature. J. A. WILCKEN

539.219

4776. Interfacial free energy of coherent twin boundaries in copper. R. L. FULLMAN. *J. Appl. Phys.*, **22**, 448-55 (April, 1951).

The ratio of the interfacial free energy of coherent twin boundaries to the average grain boundary free energy in Cu has been measured by means of the dihedral angles formed at the intersections of twin boundaries and grain boundaries with each other and with a Cu/Pb vapour interface. The mean value found for the ratio is 0.035 ± 0.006 .

A.

539.219 : 548.0

4777. Crystallography and interfacial free energy of noncoherent twin boundaries in copper. R. L. FULLMAN. *J. Appl. Phys.*, **22**, 456-60 (April, 1951).

The crystallography and interfacial free energy of noncoherent twin boundaries in Cu have been investigated. It is found that the noncoherent twin boundary is approximately parallel to a $\{113\}$ plane of one crystal and to a $\{335\}$ plane of the other. The ratio of the interfacial free energy of noncoherent twin boundaries to the average grain boundary free energy in Cu is found to be 0.80 ± 0.015 . Two measurements by a second method confirm the magnitude of this value.

A.

539.23 : 537.534

4778. A thick target for synchrotrons and betatrons. E. M. McMILLAN. Note in *Rev. Sci. Instrum.*, **22**, 117 (Feb., 1951).

539.231

4779. Measurements on the oxidation of thin metallic films (Ni, Fe and Pb). A. VAN ITERBEEK, L. DE GREVE AND M. FRANÇOIS. *Médec. K. Vlaamse Acad. Wetensch. Belg.*, **12** (No. 16) 17 pp. (1950).

The degree of oxidation is measured by means of the change of the electrical resistance, and is studied as a function of temperature, between 75°C and the temperature of liquid air. The curves obtained for the rate of oxidation as a function of time, have a certain analogy with those which are found in adsorption phenomena of gases on solid surfaces (Freundlich or Langmuir isotherms). Cabrera and Mott [Abstr. 532 (1950)] have treated theoretically the oxidation phenomena on a plane metal surface. The authors think, however, that this theory cannot be applied in the case of metal films because those films have a granular structure.

A.

539.234

4780. On the blisters produced on the evaporated aluminium film. S. NAWATA. *Sci. Rep. Res. Inst. Tôhoku Univ., Ser. A*, **2**, 331-40 (April, 1950).

Comparative studies were done on continuous and discontinuous evaporation of thin Al film on glass. It was thus ascertained that continuous evaporation is liable to produce blisters on the evaporated surface. It was concluded that to avoid such blisters the evaporated thickness before the bulk state is reached must be evaporated each time and the stopping time intervals should exceed that required for the evaporated Al atoms to complete the agglomeration.

A.

539.234

4781. The production, properties and uses of thin films condensed in vacuo. L. HOLLAND. *Vacuum*, **1**, 23-36 (Jan., 1951). Review. 56 refs.

539.234

4782. Density control in the manufacture of rhodium filters. W. ZEHEND. Letter in *Vacuum*, **1**, 38-9 (Jan., 1951).

539.234

4783. Lattice distortion spectrum of evaporated gold. P. G. WILKINSON. *J. Appl. Phys.*, **22**, 419-23 (April, 1951).

Au was deposited in various pressures of N from 0.001μ to 110μ at low temperatures. The electrical resistance of the Au film was observed to decrease as it warmed, enabling the distribution of lattice distortions to be computed as a function of decay energy. The distortion spectrum from 70×10^{-14} to 130×10^{-14} erg was found to consist of 3 peaks—one at 80×10^{-14} , one at 100×10^{-14} and one at 120×10^{-14} erg. The relative number of distortions for a particular decay energy was found to decrease as the N pressure increased. The final resistivities of the Au films were shown to be dependent on the film thickness over the range 40Å to 420Å in a manner which agreed with theory and gave a value of 970Å for the mean free path of the conduction electrons.

A.

539.26
4784. X-ray measurement of short range order in Ag-Au. N. NORMAN AND B. E. WARREN. *J. Appl. Phys.*, **22**, 483-6 (April, 1951).

The diffuse intensity from single crystals of AgAu and Ag₃Au was measured with crystal monochromated Cu K α radiation and a Geiger counter spectrometer. Measurements were made at a series of points in the (h_1h_20) layer of reciprocal space. The measurements were made at both room temperature and at 160°K to allow a correction for temperature diffuse scattering. For the final annealing temperature of 300°C, the short-range order parameters obtained were $\alpha_1 = -0.08$ for AgAu and $\alpha_1 = -0.05$ for Ag₃Au. A.

539.26 : 669

4785. Some new uses of X-rays in metallography. A. GUINIER. *Trans Instrum. Meas. Conf., Stockholm* (1949) 60-4 (1950) *In French*.

Methods of investigation of the mosaic structure of metal crystals, and the defects in structure by means of fixed monocrystals, and a description of the planar, linear and unsystematic irregularities in metal crystals.

C. TURNER

539.266
4786. Diffraction of X-rays by mixtures of ethyl alcohol and benzene. F. CENNAMO. *Atti Accad. Naz. Lincei (R.C. Cl. Sci. Fis. Mat. Nat.)* **9**, 339-43 (Dec., 1950) *In Italian*.

Using the K α radiation of Cu made monochromatic by filtration with Ni, the X-ray diffraction of a series of mixtures of C₂H₅OH and C₆H₆ ranging from 100% ethyl alcohol to 100% benzene have been studied. The results are discussed in relation to the cybotactic state hypothesis of Stewart.

T. A. CHALMERS

539.27
4787. Control by electron diffraction of the purity of liquid hydrocarbons. J.-J. TRILLAT AND C. PIERRÉE. *J. Rech. Cent. Nat. Rech. Sci.*, No. 13, 183-5 (1950) *In French*.

Drops of liquid hydrocarbons (pentane, cyclohexane, octane, etc.) are allowed to evaporate on very thin films of collodion and the film is then examined by electron diffraction. Even with the purest samples there is a diffraction pattern indicating the presence of a fatty substance of higher molecular weight which crystallizes in orthorhombic crystals. Sometimes the crystals are large enough to give single spots, but more often rings are obtained. The possibility of these residual films being due to the short chain hydrocarbon itself is considered but rejected and the conclusion is drawn that electron diffraction will detect the presence of impurities which cannot be detected by the usual methods.

J. IBALL

539.27 : 541.182.5

4788. Direct observation of gel structure with the electron microscope. R. D. VOLD, H. F. COFFER AND R. F. BAKER. Letter in *J. Coll. Sci.*, **5**, 586-8 (Dec., 1950).

539.27

4789. Specimen grids made from spiders' webs for electron microscopy. H. DESSENS AND C. FERT. *C.R. Acad. Sci., Paris*, **232**, 606-8 (Feb. 12, 1951) *In French*.

It is possible to utilize spiders' webs as specimen

supports for electron microscopy and electron diffraction. Fine particles may then be examined without the necessity for a supporting film. The diameter of an individual thread is often less than 100Å. The technique of preparing such threads is described together with the way in which the specimens are attached and the completed preparation is handled.

J. THEWLIS

539.27 : 548.5

4790. Observation of spiral growth-steps in *n*-paraffin single crystals in the electron microscope. I. M. DAWSON AND V. VAND. Letter in *Nature, Lond.*, **167**, 476 (March 24, 1951).

539.27

4791. Study of precipitates of C and N in iron with an electron microscope. J. RADAVICH AND C. WERT. *J. Appl. Phys.*, **22**, 367-71 (April, 1951).

The physical shapes of the precipitates have been determined in each case as well as the fineness of dispersion. The results of the investigation confirm the conclusions drawn from internal friction measurements made on these alloys and reported earlier. A.

ELASTICITY . STRENGTH . RHEOLOGY 539.3/.8

539.319

4792. Formulas for the determination of residual stress in wires by the layer removal method. W. T. READ, JR. *J. Appl. Phys.*, **22**, 415-16 (April, 1951).

The distribution of residual axial stress in a beam or wire of circular cross-section is derived as a function of the moment required to straighten the wire after removal of successive layers of material. Application of the formulae involves two graphical differentiations and integrations of experimental curves. A.

539.32 : 534.23

4793. Elastic constants of gelatinous substances. A. M. SRIVASTAVA. *J. Amer. Chem. Soc.*, **73**, 489-90 (Jan., 1951).

Ultrasonic waves are generated by a pulse transmitter, impinge upon a slab of the gel being studied, are received by a quartz crystal and the resulting signal is displayed on a cathode-ray tube. Rotation of the slab alters the angle of incidence, and in two positions sharp minima in the transmitted intensities are observed due to total reflection of the waves set up in the gel, the two waves being due to resolution of the incident beam into the longitudinal and transverse components. The velocity of the waves can be computed from the critical angles and, from these and the density, the elastic constants are computed. Tests were made on iron silicate gel using frequencies of 0.625, 1.250, 2.250 and 2.500 Mc/s. The velocity of shear waves decreased with temp. within the range 20-70°C and increased with test frequency. Young's modulus increased with frequency and with time. Fuller details of the results and of tests on other gels of the Weimarn type will be published later.

A. C. WHIFFIN

539.37 : 538.65

4794. Anelasticity of ferromagnetics: magneto-elastic relaxation in nickel. T. SUZUKI AND M. YAMAMOTO. *Sci. Rep. Res. Inst. Tôhoku Univ., Ser. A*, **2**, 68–80 (Feb., 1950).

Discusses the inter-correlation between Bloch walls and structural imperfections in ferromagnetics, both of which are movable under an applied stress. The stress-relaxation accompanied by the movement of lattice imperfections will affect the displacement of the Bloch wall. This points to a possibility that a gradual displacement of Bloch walls or their delayed jerky motion plays an important role in transient creep of ferromagnetics (magneto-elastic relaxation). In fact such a phenomenon was found in an annealed Ni from the measurements of transient creep without magnetic field in the one case and with field of 400 oersteds in the other, which was performed under the application of very small stresses of the order of $10^6 \sim 10^7$ dynes/cm² at elevated temperatures. A.

539.374

4795. "Temperature interval" of lattice transformation. I. S. TAKEUCHI AND H. SUZUKI. *Sci. Rep. Res. Inst. Tôhoku Univ., Ser. A*, **2**, 43–9 (Feb., 1950).

An attempt to explain the causes of retained austenite on the lattice transformation is undertaken. Lattice transformation in a small fraction of the crystal produces internal strain in the remaining austenite, which makes the resistance increase against the following transformation; but when the temperature of the crystal decreases, an excessive free energy is stored by increase of supercooling, and then the transformation develops. A relation is assumed between the free-energy difference dissipated during the lattice transformation and the mechanical energy required for plastic deformation. The dependence of amounts of transformation on temperature is then evaluated through correspondence between the work hardening in plastic deformation and this phenomenon. A.

539.374

4796. Theory of plasticity. I. Correlation between lattice transformation and plastic gliding in metals. S. TAKEUCHI AND H. SUZUKI. *Sci. Rep. Res. Inst. Tôhoku Univ., Ser. A*, **2**, 50–9 (Feb., 1950).

Two fundamental relations, which are essential to express the resistance against plastic gliding in terms of the thermodynamic function, were derived by considering the structure of dislocation. One is a relation which connects the free energy difference ΔG dissipated during the lattice transformation with the mechanical energy $f \cdot \Delta L$ required for the plastic gliding and it has been assumed in a previous report (preceding Abstr.). Here f is the resistance against the plastic gliding and ΔL the amount of deformation in the process of lattice transformation, its numerical value being 0.306. Another relation gives a method to obtain the free energy difference ΔG for a crystal in which the lattice transformation cannot take place under the usual condition. A.

539.374

4797. Theory of plasticity. II. Critical shear stress of binary alloys. S. TAKEUCHI AND H. SUZUKI.

Sci. Rep. Res. Inst. Tôhoku Univ., Ser. A, **2**, 60–7 (Feb., 1950).

The critical shear stresses of binary alloys were calculated by means of two relations which were derived in Part I. The curves of critical shear stress plotted against the concentration of binary alloys take various forms for different values of X and Y , where $X = RT/H$, $Y = \Phi_1/H$ and $H = (F_a^i - F_b^i) - (F_b^j - F_b^k)$. F_a^i , F_b^i , F_b^j and F_b^k are the Helmholtz's free energy of pure crystal composed of atoms A or B in the real or in the imaginary crystal phase respectively, Φ_1 , being the so-called ordering energy of the alloy. The quantity H hardly depends on temperature at sufficiently high temperatures. As $Y/X = \Phi_1/RT$ becomes smaller, the critical stress curve plotted against the concentration approaches to a symmetric form. But it is very unsymmetric for small values of X and the central part of the curve becomes flat for large Y . The comparison with observations reveals good agreement in the cases of Au–Ag, Cu–Ni and Cu–Zn alloys. A.

539.374

4798. The theory of non-linear elasticity. Y. NAKAGAWA. *Mem. Fac. Engng Kyoto Univ.*, **12**, 66–86 (July, 1950).

A simple explanation is given, in terms of inter-molecular forces, of non-linear stress-strain relations suitable for describing the general elastic behaviour of (e.g.) cast iron and concrete. J. G. OLDROYD

539.374

4799. The theoretical basis and interpretation of the Schnadt notch test. J. H. PALM. *Smit Meded.*, **5**, 98–117 (Oct.–Dec., 1950).

Summarizes that part of the theory of plasticity on which Schnadt appears to have based his considerations, followed by a description of the terminology, diagrams and the Schnadt test method proper and concluded with some further observations on the theoretical basis and the practical interpretation of the test method with particular reference to the application to welded structures. J. VAN WAASDIJK

539.374

4800. A phenomenological theory of visco-elastic behaviour. III. D. TER HAAR. *Physica*, **16**, 839–50 (Dec., 1950).

The first two papers [Abstr. 3094–5 (1951)] dealt with the behaviour of visco-elastic materials under static experiments. The present paper discusses periodic phenomena. At each frequency, the material otherwise described by a relaxation frequency spectrum $N(\nu)$ can be described by an equivalent Kelvin element, the modulus $E_1(\omega)$ and viscosity $\eta(\omega)$ of which are completely determined by $N(\nu)$ and depend on the frequency. It is also possible to give an equivalent Maxwell element. Various methods are described to determine from the complex modulus $E(\omega)$ [$= E_1(\omega) + i\omega\eta(\omega)$] the spectrum $N(\nu)$. The determination of $E_1(\omega)$ and $E_2(\omega)$ [$= \omega\eta(\omega)$] from the resonance curves observed in experiments with vibrating bars is discussed, and also the propagation of waves through a visco-elastic medium, a phenomenon which can be used to determine $E_1(\omega)$ and $E_2(\omega)$ for high frequencies. A.

539.374

- 4801. On the transverse stresses which develop in tensile tests.** B. JAOUŁ. *C.R. Acad. Sci., Paris*, **232**, 477-9 (Feb. 5, 1951) *In French*.

Experiments on the plastic elongation of Al test pieces showed that the ratio diametral contraction/longitudinal extension was $\frac{1}{2}$ for solid cylinders and $\frac{1}{3}$ for very thin-walled tubes. This indicates the existence of important transverse stresses in the cylinder. Calculations based on the forces required to produce plastic deformation in the two cases are regarded as verifying the von Mises' yield criterion. A. T. PRICE

539.374

- 4802. The practical value of a theory of elasto-plastic equilibrium.** G. COLONNETTI. *C.R. Acad. Sci., Paris*, **232**, 584-5 (Feb. 12, 1951).

A discussion of the usefulness of a theory of stress-systems in elasto-plastic materials based on the assumption that the state of equilibrium is characterized by the minimum of a certain function with respect to all possible stresses compatible with the external forces and with the plastic deformations, which are regarded as given. The theory fails to take account of many physical facts, but it is claimed to be of some value because, by rejecting inconvenient complexities, it forms a possible basis for certain calculations. A. T. PRICE

539.374 : 539.4

- 4803. Effect of free surface on the yielding resistance of materials.** T. NISHIHARA AND S. TAIRA. *Mem. Fac. Engng Kyoto Univ.*, **12**, 90-118 (Jan., 1951).

Stress measurements by X-ray methods on steels and Al deformed plastically in tension or compression indicate a non-uniform distribution of stress over the cross-section. This is deduced to be a consequence of the restrictive influence exerted by neighbouring grains, such that the surface grains can deform more easily than those in the interior. A theoretical treatment based on the concept of a yielding resistance as applied to a mosaic of blocks (grains) is set out and some quantitative results deduced which, in the authors' view, justify the theory. A. J. KENNEDY

539.43

- 4804. On the internal stress and the internal friction of metals. I. On the mechanism of fatigue.** H. SATO. *Sci. Rep. Res. Inst. Tôhoku Univ., Ser. A*, **1**, 203-6 (Oct., 1949).

Vibration experiments were carried out to determine the internal friction in soft steel and Al. It is concluded that the internal stress increases for small values of the frequency of vibration and subsequently reaches an equilibrium value. Finally fracture is initiated by a small crack when the internal friction reaches a critical value. The results are discussed on the basis of Orowan's theory. E. P. WOHLFARTH

539.43

- 4805. On the internal stress and the internal friction of metals. II. The change of the internal friction of Ni_3Fe during the formation of superlattice.** H. SATO. *Sci. Rep. Res. Inst. Tôhoku Univ., Ser. A*, **1**, 207-11 (Oct., 1949).

Vibration experiments, described in preceding Abstr., allow estimates to be made of the "wavelength" of the internal stress variation. Comparison is made with the value estimated from magnetic

properties. The discrepancy between the two values was found to be large; a tentative interpretation is given. E. P. WOHLFARTH

539.434

- 4806. Nonclassical reaction kinetics.** H. EYRING AND P. GIBBS. *Science*, **113**, 104-5 (Jan. 26, 1951).

The interpretation of the plastic flow of metals by Eyring and Fredrickson [see Abstr. 314 (1949)] assuming a classical expression for the rate of passage across an energy barrier is altered by using the quantum mechanical expression. The effective potential energy V to prevent motion is assumed to be relaxed at every point by an amount proportional to the stress, to relax the stress. This is due to the local distortion. The new expression gives the correct temperature dependence naturally. Since electrical conductivity can be treated in a similar fashion an analogy is set up between the variation with composition in alloys of the hardness and resistivity. This is borne out by the experimental curves. G. J. KYNCH

539.434

- 4807. The deformation of gold wire at high temperature.** B. H. ALEXANDER, M. H. DAWSON AND H. P. KLING. *J. Appl. Phys.*, **22**, 439-43 (April, 1951).

Au wires were subjected to small tensile stresses at high temperatures and the strain-time relationships were determined. These creep curves were similar to those generally obtained for metals at lower temperatures, except that the minimum creep rate was proportional to the applied stress; i.e. the flow was viscous. This coefficient of viscosity was determined as well as its variation with temperature. The surface energy of solid Au was also determined. Theories that have been presented to explain the viscous behaviour of metals are briefly discussed. A.

539.621

- 4808. Frictional properties of tungsten carbide and of bonded carbides.** K. V. SHOOTER. *Research, Lond.*, **4**, 136-9 (March, 1951).

The frictional properties of W carbide and of 4 different bonded carbides have been investigated at slow sliding speeds and under heavy load. The surface damage when carbide and metal slide together is comparable with that found for other softer metals. The presence of the Co in the bonded carbides does not produce any very great difference in behaviour from W carbide itself. Repeated stressing of the bonded carbide leads to a sudden increase of heavy wear and to a rise in friction. A.

539.89 : 539.215

- 4809. Statics of powdered material under compression.** T. NISHIHARA AND T. KORI. *Mem. Fac. Engng Kyoto Univ.*, **12**, 53-65 (July, 1950).

When a powder is compressed in a cylindrical vessel, a linear relationship between the compressive strain and the logarithm of the applied pressure is observed. A linear relationship still holds when the effect of finite wall friction is eliminated by extrapolation from experiments with different wall coatings; general equations relating stresses and strains in a powder are built up on this basis. The theory agrees with experiments on powders of Cu, Al, Fe, etc., involving principal strains of both signs. The stress in a compressed powder can be correlated with the Shore hardness of the surface. J. G. OLDROYD

539.893 : 550.4

4810. Quantum-theoretical densities of solids at extreme compression. W. M. ELSASSER. *Science*, **113**, 105-7 (Jan. 26, 1951).

A comparison of the densities and compounds up to pressures of 10^5 atmospheres determined by

Bridgman and calculations for elements on the Fermi-Dirac-Thomas model at rather higher pressures shows that the two fit together reasonably well. The density of the earth determined from seismic data corroborates the theory that the earth's core is of iron.
G. J. KYNCH

PHYSICAL CHEMISTRY 541

PHASE EQUILIBRIUM . CHEMICAL REACTIONS 541.11/.12

541.11

4811. Calculated thermochemical properties for hydrazine-hydrogen peroxide reaction at high pressures. W. J. BARR AND E. J. WILSON, JR. *J. Chem. Phys.*, **19**, 470 (April, 1951).

A liquid bireactant system, consisting of a stoichiometric mixture of anhydrous hydrazine and hydrogen peroxide, is evaluated in terms of the resultant equilibrium temperature-pressure-density relationship corresponding to chamber pressures over the range 10 000 to 185 000 lb/in². The analysis is based on the use of the reactants both at constant volume and at constant pressure, and data pertaining to the mole fractions of components of the product gas, its molecular weight and covolume are included for each case.
A.

541.121

4812. Carbon-14 isotope effect in an inorganic equilibrium. D. R. STRANKS AND G. M. HARRIS. Letter in *J. Chem. Phys.*, **19**, 257-8 (Feb., 1951).

541.123.2

4813. The phase diagram of the BaO-TiO₂ system. W. O. STATTON. *J. Chem. Phys.*, **19**, 33-40 (Jan., 1951).

A method for accurately observing phase changes at high temperatures has been developed; it employs a microfurnace and uses samples of oxide mixtures weighing less than 1 mg. The samples were observed and their temperatures measured with an optical pyrometer specially adapted for this purpose and calibrated for the furnace radiation. The existence of 4 compounds, BaTi₄O₉, BaTi₂O₅, BaTiO₃ and Ba₂TiO₄, was demonstrated by liquidus curves and X-ray diffraction. A phase change of BaTiO₃ below the solidus temperature was observed; all oxide mixtures with less than 80 mole % TiO₂ showed this intermediate BaTiO₃ phase at about 1 450°C. Single crystals of BaTi₄O₉, BaTi₂O₅ and BaTiO₃ were grown from ternary melts of BaCO₃, TiO₂ and BaCl₂. The compound, BaTi₄O₉, showed extensive polymorphism. Attack by molten BaO mixtures on Mo and Pt produced the compounds, BaMoO₄, Ba₃Pt₂O₇ and Ba₃Ti₂PtO₉.
A.

541.123.5

4814. Exchange between N₂³⁰ and N₂²⁸ over iron catalysts. J. T. KUMMER AND P. H. EMMETT. *J. Chem. Phys.*, **19**, 289-92 (March, 1951).

The rates of exchange between N₂²⁸ and N₂³⁰ obtained on doubly- and singly-promoted Fe catalysts is of the right order to be accounted for by assuming that all N evaporating from the surface of the catalyst is

completely equilibrated with respect to the N isotope exchange. Large concentrations of H (50% H₂ in N₂) markedly accelerate the reaction. Small traces of surface oxides poison the Fe catalysts severely for the isotope exchange.
A.

541.123.5

4815. Kinetics of the ammonia-deuterium exchange by a microwave method. J. WEBER AND K. J. LAIDLER. *J. Chem. Phys.*, **19**, 381-2 (March, 1951).

541.124

4816. Concerning the steric factor of free radical reactions. R. GOMER AND L. M. DORFMAN. Letter in *J. Chem. Phys.*, **19**, 136 (Jan., 1951).

541.124

4817. A reply to a letter to the editor entitled, "Concerning the steric factor of free radical reactions" by Gomer and Dorfman. M. SZWARC. Letter in *J. Chem. Phys.*, **19**, 380 (March, 1951).

See preceding Abstr.

541.124

4818. Remarks on the calculating rates of some radical reactions. M. SZWARC. Letter in *J. Chem. Phys.*, **19**, 256-7 (Feb., 1951).

541.124

4819. Fischer-Tropsch reaction mechanism involving stepwise growth of carbon chain. R. B. ANDERSON, R. A. FRIEDEL AND H. H. STORCH. *J. Chem. Phys.*, **19**, 313-19 (March, 1951).

Expressions are derived which predict satisfactorily the observed isomer and C number distribution of products from Fe and Co catalysts in the Fischer-Tropsch synthesis. These expressions are based on 3 schemes of stepwise addition of 1 C atom to the end or adjacent-to-end C's of the longest C chain of the growing group at the catalyst surface. The implications of these schemes to some general aspects of the reaction mechanism are considered.
A.

541.124

4820. The reactions of radicals produced by the action of sodium on alkyl iodides. A. A. COMSTOCK AND G. K. ROLLEFSON. *J. Chem. Phys.*, **19**, 441 (April, 1951).

The products of the reactions of Na vapour with methyl and ethyl iodide vapours have been analysed. It has been found that in the reaction with methyl iodide the principal product is ethane, but considerable amounts of methane, ethylene and hydrogen are also formed. With ethyl iodide the principal product was butane, with lesser amounts of ethane, ethylene, methane and hydrogen. It was also noted that in the latter system considerable amounts of propane

appeared which could be accounted for as a pyrolysis product of the butane formed. The results have been compared with those obtained by others with similar systems and with the results obtained in the photolyses of mercury dimethyl and mercury diethyl. It is concluded that at low temperatures the dominant reaction for both ethyl and methyl radicals is for two to combine to form a saturated hydrocarbon. At higher temperatures, disproportionation reactions and reactions of the radicals with other molecules must be taken into account and eventually become the dominant reactions.

A.

541.124

4821. The reaction of methylcyclopentane with Hg 6^3P_1 atoms. M. SCHLOCHAUER AND H. E. GUNNING. *J. Chem. Phys.*, **19**, 474 (April, 1951).

The reaction of methylcyclopentane with photo-excited Hg 6^3P_1 atoms was investigated in a static system at $29.35 \pm 0.01^\circ\text{C}$, over a range of initial pressures of 5–110 mm. After an initial slight pressure rise, the reaction exhibited a linear pressure decrease, the magnitude of which increased linearly with initial pressures of methylcyclopentane above 15 mm. The average rate of H formation also increased with initial pressure of methylcyclopentane and decreased with time in the course of a run. The products found were H, methylcyclopentenes and a heavy fraction with the formula $\text{C}_{12}\text{H}_{22}$. Upon the basis of chemical and physical properties, strengthened by kinetic considerations, it was concluded that the $\text{C}_{12}\text{H}_{22}$ compound was predominantly dimethyldicyclopentyls. Quantum yields reached a maximum of 0.44 for H formation and 0.42 for methylcyclopentane consumption.

A.

541.124 : 541.6

4822. The effect of intramolecular configuration on the rate of unimolecular solvolysis of aralkyl chlorides. G. BADDELEY AND J. CHADWICK. *J. Chem. Soc.* (1951) 368–74 (Feb.).

3-Hydroxy- and 3-chloro-1 : 2-benzocycloheptene have been prepared. The rates of ethanolysis of 1-phenyl-, 1-*o*-tolyl- and 1-mesityl-ethyl chlorides and of 1-chloroindane, 1-chlorotetralin, and 3-chloro-1 : 2-benzocycloheptene have been measured at two temperatures; in general, increased reactivity is caused by diminution in activation energy. The high reactivity of 1-chloro-indane and 1-chlorotetralin is related to the essentially planar structure of the respective carbon skeletons. It is argued that ionization of the other chlorides is accompanied by intramolecular reorientation and that this is subject to steric hindrance.

A.

541.124 : 541.64

4823. Kinetics of the polymerization of styrene by Friedel-Crafts catalysts. D. O. JORDAN AND A. R. MATHIESON. Letter in *Nature, Lond.*, **167**, 523–4 (March 31, 1951).

541.124 : 545.844

4824. The Jones reductor: a model for the kinetics of chromatography. K. KNOX AND H. C. THOMAS. *J. Chem. Phys.*, **19**, 224–7 (Feb., 1951).

The Jones reductor can be made to assume a steady state of operation in the reduction of ferric sulphate.

Its behaviour under such conditions strongly indicates that the rate limiting process is the diffusion of ferric ion through a static film of solution around the solid particles. This is particularly evidenced by the exponential dependence of the extent of reduction on the square root of the flow rate. The behaviour of the reductor as a function of Zn ion concentration, Zn amalgam particle size and temperature, also agrees with this result.

A.

541.126

4825. Erratum: Kinetics of OH radicals from flame emission spectra. I. K. E. SHULER. Letter in *J. Chem. Phys.*, **19**, 139 (Jan., 1951). See Abstr. 1392 (1951).

541.126

4826. Burning velocity determination. III. Burning velocities of ethylene + air + carbon dioxide mixtures. J. W. LINNETT AND M. F. HOARE. *Trans Faraday Soc.*, **47**, 179–83 (Feb., 1951).

See Abstr. 259 (1951) for Part II. The results are considered in relation to the mechanism of flame propagation, along with results for ethylene + air and ethylene + air + nitrogen flames.

A.

541.126

4827. The thermal hydrogen-oxygen reaction at relatively low temperatures. H. P. BROIDA AND O. OLDENBERG. *J. Chem. Phys.*, **19**, 196–202 (Feb., 1951).

In the behaviour of the thermal hydrogen-oxygen reaction there is an apparent discrepancy. The second explosion of the thermal reaction occurs over a wide range of low temperatures down to 350°C , even though the rate of steady thermal reaction is very nearly zero. The authors used a criterion stated by Lewis and von Elbe to show that the same volume chain which explains the reaction at higher temperatures applies to the low temperature range. The inhibition period within the low pressure explosion region and the branching of the chains are briefly discussed.

A.

541.126

4828. Two new sequences of the system $3\text{II} \rightarrow 3\text{Z}$ of the NH radical observed in the explosive decomposition of hydrazoic acid, N_3H . G. PANNETIER. *C.R. Acad. Sci., Paris*, **232**, 817–18 (Feb. 26, 1951) *In French*.

New bands of the NH radical have been identified in the decomposition products of N_3H vapour, and the mechanism of the decomposition is interpreted.

W. R. ANGUS

541.127

4829. Kinetics of the rapid gas phase reaction between NO , NO_2 , and H_2O . L. G. WAYNE AND D. M. YOST. *J. Chem. Phys.*, **19**, 41–7 (Jan., 1951).

Using the absorption of light by NO_2 as a measure of its concentration, the rate of the gas phase reaction $\text{NO} + \text{NO}_2 + \text{H}_2\text{O} = 2\text{HNO}_2$ was measured over a fivefold range of water vapour and NO_2 concentrations, with NO greatly in excess. Changes in light intensity were detected by means of an electron-multiplier photo-tube and recorded by photographing the screen of a cathode-ray oscilloscope. Half-times as short as 0.014 sec were observed. The reaction

rate was found to depend more strongly upon the concentration of water vapour than upon that of NO_2 and to be kinetically consistent with a mechanism involving termolecular collisions. The equilibrium constant of the reaction has been calculated and its order of magnitude experimentally confirmed, and a lower limit has been fixed for the rate of dissociation of N_2O_3 . A.

541.127

4830. The recombination of methyl radicals. D. M. MILLER AND E. W. R. STEACIE. *J. Chem. Phys.*, **19**, 73-7 (Jan., 1951).

An investigation has been made of the rate at room temperature of recombination of methyl radicals by photolysing mercury dimethyl in the presence of NO and comparing the rates of the reactions $\text{CH}_3 + \text{CH}_3 \rightarrow \text{C}_2\text{H}_6$ and $\text{CH}_3 + \text{NO} \rightarrow \text{CH}_3\text{NO}$. It is concluded that $k_1^{1/2}/k_2$ is approximately equal to 3×10^{-5} . If Forsyth's value for k_2 is accepted, this leads to a collision yield for methyl radical recombination of 4.4×10^{-5} . A.

541.127

4831. The rate constant of ethane formation from methyl radicals. R. GOMER AND G. B. KISTIAKOWSKY. *J. Chem. Phys.*, **19**, 85-91 (Jan., 1951).

The rotating sector technique has been applied to a determination of the rate constant of methyl radical recombination in the photo-decompositions of acetone and mercury dimethyl, using the small but accurately measurable rate of methane formation as a measure of methyl steady-state concentration. The resulting value of the recombination rate constant is $4.5 \times 10^{13} (\text{moles/cc})^{-1} \text{sec}^{-1}$, with an activation energy of $E = 0 \pm 700 \text{ cal}$ regardless of radical source. A.

541.127

4832. The kinetics of the forward and reverse reactions for the vapor phase thermal bromination of chloroform. J. H. SULLIVAN AND N. DAVIDSON. *J. Chem. Phys.*, **19**, 143-8 (Feb., 1951).

The rates of the forward and reverse reactions for the homogeneous vapour phase thermal bromination of chloroform, $\text{CHCl}_3 + \text{Br}_2 = \text{CBrCl}_3 + \text{HBr(A)}$, have been measured in the range $420\text{--}455^\circ\text{K}$ and are given by

$$-d(\text{Br}_2)/dt = k_f(\text{CHCl}_3)(\text{Br}_2)^{1/2}[1 + k_2(\text{HBr})/k_3(\text{Br}_2)]^{-1} - k_r(\text{CBrCl}_3)(\text{Br}_2)^{1/2}[1 + k_3(\text{Br}_2)/k_2(\text{HBr})]^{-1};$$

where

$$\log_{10} k_f (\text{litre/mole})^{1/2} \text{sec}^{-1} = (-32\,030/4.575T) + 11.15, \log_{10} k_r = (-32\,930/4.575T) + 12.70.$$

The directly determined equilibrium constant for (A) agrees well with the kinetic value, $K_e = k_1 k_3 / k_2 k_4$; $\log_{10} K_e = (900/4.575T) - 0.15$. From these data, for CCl_3Br , $\Delta H_f^\circ, 298^\circ = -9.4 \text{ kcal}$, $S^\circ, 298^\circ = 80 \text{ eu}$, S° was calculated as 80 eu from electron diffraction and spectroscopic data. The equation for k_4 is identical with that obtained in a previous study of the exchange of radioactive bromine between Br_2 and CBrCl_3 , thus proving this free radical mechanism for the exchange reaction. A.

541.127

4833. On the detonation of secondary explosives by an electric spark. R. SCHALL. *C.R. Acad. Sci., Paris*, **232**, 706-8 (Feb. 19, 1951) *In French*.

The explosive under investigation was contained in a slotted Cu tube (4 mm int. dia.). One end of the tube was closed by a metal cap, held a few mm from the end of the tube by a transparent insulating sleeve, the space between the cap and the tube being filled with explosive. An electric spark was passed from the cap to the tube, and the progress of the explosive reaction was observed with a rotating-drum camera sighted on the slot. It was found that passage of a spark is followed by a rapid deflagration, which develops into a detonation after $1\text{--}100 \mu\text{sec}$ if the spark is strong enough. The minimum electrical energy necessary to initiate detonation (20×10^7 ergs for hexogen) is of the same order as the thermal energy released by the minimum primary explosive initiator (32×10^7 ergs) or the mechanical energy of impact required to cause initiation (6×10^7 ergs); the min. electrical initiating energy is quite reproducible (to about 4%) and may serve as a measure of sensitivity. A. SCHOFIELD

541.127 : 541.14

4834. The relative rates of reaction of hydrogen and tritium hydride with chlorine. W. M. JONES. *J. Chem. Phys.*, **19**, 78-85 (Jan., 1951).

The ratio of the specific rate constant for H_2 to that for HT in the photo-chemical reaction with Cl has been determined at 4 temperatures and is represented by $R = (1.35 \pm 0.03) \exp \{(552 \pm 7)/RT\}$ to within about 0.3%. The ratio is found to be the same when the reaction is initiated by the T β -particles. The data are considered from the viewpoint of the theory of absolute reaction rates. A.

541.128

4835. Catalysis in protein-like systems. A. GOUDOT. *C.R. Acad. Sci., Paris*, **232**, 704-5 (Feb. 19, 1951) *In French*.

The presence of the liquid molecules is taken into account explicitly in the Hamiltonian. Groups of liquid molecules form chains which allow reactions over long distances even at feeble enzyme concentrations. At higher temperatures these group chains become smaller and resonance between enzymes, groups of liquid molecules and macromolecules of the reaction may cease. J. JACOBS

541.128 : 538.66

4836. Thermomagnetic investigations of promoted and unpromoted iron oxide and iron catalysts. L. R. MAXWELL, J. S. SMART AND S. BRUNAUER. *J. Chem. Phys.*, **19**, 303-9 (March, 1951).

The Curie temperature (θ) and intensity of magnetization of certain unreduced and reduced iron oxide catalysts have been determined. For the singly promoted unreduced systems of Fe_3O_4 containing small amounts of one of the following, Na_2O , K_2O , Cs_2O , BaO , B_2O_3 , Al_2O_3 , or SiO_2 , θ was found to be practically the same as for Fe_3O_4 , but large reductions in the saturation intensity of magnetization (I_s) were observed. Doubly promoted unreduced systems were also studied. Magnetic measurements on the

reduced materials gave values of θ the same as for pure iron. The extent to which the promoters go into solid solution, both for the unreduced and reduced materials, is determined. Additional unreduced unpromoted iron oxides were investigated that had variable ratios (γ) of $\text{Fe}^{++}/\text{Fe}^{+++}$. A.

541.128 : 541.64

4837. The effect of different catalysts on the polymerization of styrene. R. N. HAWARD AND W. SIMPSON. *Trans Faraday Soc.*, **47**, 212–25 (Feb., 1951).

ELECTROCHEMISTRY 541.13

541.133

4838. Conductivities of strong electrolytes in aqueous solution. R. L. EVANS. *J. Chem. Phys.*, **19**, 310–12 (March, 1951).

The concentration dependence of the conductivities of strong electrolytes is of interest in both theory and application. Older theoretical and empirical equations fail at high concentrations. Three empirical equations for the concentration dependence of conductivity are presented. The first of these contains only a single fitted parameter. Each of the other equations contains two parameters and follows the experimental curves up to high concentrations. A description of two anomalies in the behaviour of tetramethyl ammonium salts is also given. A.

541.133.1

4839. Ionic transport in liquid silicates. J. O'M. BOCKRIS, J. A. KITCHENER AND A. E. DAVIES. Letter in *J. Chem. Phys.*, **19**, 255 (Feb., 1951).

A silicate, heated under vacuum in a Mo cell with a C anode and an Al_2O_3 anode compartment, liberates O_2 during electrolysis which attacks the C, giving a mixture of CO and CO_2 ; this is adsorbed on charcoal cooled in liquid air and analysed. The results establish the conduction as wholly ionic, within an error $\pm 5\%$. H. H. HODGSON

541.135

4840. Measurement of the density and direction of current lines in galvanic electrolytes. J. STEINER. *Arch. tech. Messen*, Issue No. 181 (Ref. V8227–3) T21 (Feb., 1951) In German.

Previous work on the contours of the current lines in electrolytes is discussed, and a new method is described for the determination of their direction which depends upon the difference of voltage between two copper wires immersed in the electrolyte, fixed at 5–6 mm apart, and arranged for rotation. From the directions of the current lines, the current density can be computed. Necessary precautions for accuracy are discussed. There are 3 diagrams and 6 references.

H. H. HODGSON

541.135

4841. The hydrogen-calomel cell. I. The hydrogen electrode. G. J. HILLS AND D. J. G. IVES. *J. Chem. Soc.* (1951) 305–10 (Feb.).

Some errors to which the hydrogen electrode is susceptible are discussed. A new form of hydrogen

electrode is described and some comments are made on the theory of operation of the hydrogen electrode. A.

541.135

4842. The hydrogen-calomel cell. II. The calomel electrode. G. J. HILLS AND D. J. G. IVES. *J. Chem. Soc.* (1951) 311–18 (Feb.).

The calomel electrode has hitherto been too erratic in behaviour in dilute solutions to be used for measurements of precision with galvanic cells without liquid junction. It is shown that the calomel electrode is capable of a very high degree of reproducibility provided that various sources of error, which have been examined in detail, are eliminated. A theory of the mechanism of operation of the electrode is suggested. A.

541.135

4843. The hydrogen-calomel cell. III. The standard E.M.F. at 25°C. G. J. HILLS AND D. J. G. IVES. *J. Chem. Soc.* (1951) 318–31 (Feb.).

The improvements in the calomel electrode described in the preceding Abstr. have allowed the standard e.m.f. of the hydrogen-calomel cell at 25° to be determined by direct extrapolation of the experimental measurements to zero ionic strength. The standard free energy of formation of Hg_2Cl_2 and the activity coefficients of aqueous HCl at 25° have been re-evaluated. A.

541.136

4844. Cells depolarized by air. Static and dynamic polarization. H. MOUREU, P. CHOVIN AND A. M. DE FICQUELMONT. *C.R. Acad. Sci., Paris*, **232**, 407–9 (Jan. 29, 1951) In French.

Polarization of a cell consisting of C and Zn electrodes with NH_4Cl as electrolyte has been studied with the C plate in an atmosphere of N_2 , thus preventing depolarization by atmospheric O_2 . With a relatively small resistance across the cell the e.m.f. falls rapidly. If the circuit is now broken the e.m.f. rises to a constant value which is lower than the e.m.f. on open circuit. This increase of e.m.f. shows a redistribution of charges within the cell, and is called "rearrangement after polarization." If a very large resistance is used across the cell the restoration of e.m.f. when the circuit is broken is negligible. Static and dynamic polarization are recognized. Static polarization is characterized by a permanent lowering of the e.m.f. of the cell, whilst dynamic polarization gives rise to a temporary reduction of e.m.f. when the cell gives a heavy current. Static polarization corresponds to a progressive change of the positive electrode from an O electrode to a H electrode.

A. J. MEE

PHOTOCHEMISTRY . RADIATION CHEMISTRY 541.14/15

541.14

4845. The reactions of methyl radicals. II. The abstraction of hydrogen atoms from paraffins. A. F. TROTMAN-DICKENSON, J. R. BIRCHARD AND E. W. R. STEACIE. *J. Chem. Phys.*, **19**, 163–8 (Feb., 1951).

See Abstr. 9071 (1950) for Part I. The reactions of

methyl radicals formed by the photolysis of acetone and deuterio-acetone with 9 paraffins have been studied from 25°C to 340°C. If the combination of methyl radicals requires no activation energy, then the activation energies found for the abstraction of H atoms are as follows: ethane, 10.4; *n*-butane, 8.3; 2-methyl propane, 7.6; *n*-pentane, 8.1; 2,2-dimethyl propane, 10.0; *n*-hexane, 8.1; 2,3-dimethyl butane, 6.9 and 7.8; 2,3,4-trimethyl pentane, 7.9; 2,2,3,3-tetra-methyl butane, 9.5 (all values in kcal). The collision theory steric factors of these reactions are all less than 10^{-3} . A.

541.14

4846. The reactions of methyl radicals. III. The abstraction of hydrogen atoms from olefins. A. F. TROTMAN-DICKENSON AND E. W. R. STEACIE. *J. Chem. Phys.*, **19**, 169-71 (Feb., 1951).

The abstraction of H atoms from 8 olefins by deuterio-methyl radicals formed in the photolysis of deuterio-acetone has been investigated over a temperature range from 180°C to 340°C. The activation energies of those reactions have been determined relative to the activation energy of the combination of methyl radicals. The activation energies are 10.0 kcal for ethylene and 7.5 ± 0.3 kcal for the other 7 olefins. The collision theory "P" factors are all of the order of 10^{-3} or less. A.

541.14

4847. The reactions of methyl radicals. IV. The abstraction of hydrogen atoms from cyclic hydrocarbons, butynes, amines, alcohols, ethers, and ammonia. A. F. TROTMAN-DICKENSON AND E. W. R. STEACIE. *J. Chem. Phys.*, **19**, 329-36 (March, 1951).

The photolysis of acetone in the presence of various compounds has been investigated between 70°C and 340°C. If the reaction $\text{CH}_3 + \text{CH}_3 = \text{C}_2\text{H}_6$ has no activation energy, then the activation energies in kcal for the reactions of the type $\text{CH}_3 + \text{RH} = \text{CH}_4 + \text{R}$ are cyclopropane 10.3, cyclobutane 9.3, cyclopentane 8.5, cyclohexane 8.3, benzene 9.2, toluene 8.3, 1-butyne 9.1, 2-butyne 8.6, methanol 8.2, ethanol 8.7, iso-propanol 7.3, methyl ether 9.5, iso-propyl ether 7.3, monomethyl amine 8.4, dimethyl amine 7.2, trimethyl amine 8.8, and ammonia 10.0. The collision theory steric factors are of the order of 10^{-3} or less for all these reactions. A table is presented summarizing the results so far obtained on methyl radical reactions by the photolysis of acetone in the presence of other compounds. The accuracy of the method and some of the general implications of the results are discussed. A.

541.14

4848. The mercury ($^3\text{P}_1$) sensitized decomposition of normal and iso-butane at high temperatures. S. BYWATER AND E. W. R. STEACIE. *J. Chem. Phys.*, **19**, 172-5 (Feb., 1951).

The reactions of both hydrocarbons result in the formation of decomposition products of butyl radicals at temperatures above 250°C. In the case of normal butane this reaction gives methane, ethane, ethylene and propylene; and with iso-butane, only methane and butane. Activation energies are assigned to the various radical decomposition steps. A.

541.14

4849. Vapor phase photolysis of formaldehyde at wavelength 3130 Å. J. G. CALVERT AND E. W. R. STEACIE. *J. Chem. Phys.*, **19**, 176-82 (Feb., 1951).

The vapour phase photolysis of formaldehyde at wavelength 3130 Å has been investigated at high temperatures. The experimental results indicate that the rate of H formation is directly proportional to the first power of the intensity of absorbed light, and at constant intensity of absorbed light the rate is accelerated by the addition of formaldehyde or inert gas with about equal efficiency. Propylene and nitric oxide inhibit the rate. The mechanism of the photo-decomposition is suggested. A.

541.14

4850. The mercury photo-sensitized decomposition of methyl chloride. C. R. MASSON AND E. W. R. STEACIE. *J. Chem. Phys.*, **19**, 183-9 (Feb., 1951).

A study has been made of the mercury photo-sensitized decomposition of methyl chloride over a pressure range of 10 mm to 640 mm, a temperature range of 72°C to 328°C, and a threefold variation in light intensity. The stoichiometric equation for the reaction at 250°C and 160 mm pressure is $3\text{CH}_3\text{Cl} = \text{HCl} + 0.97\text{CH}_4 + 0.49\text{C}_2\text{H}_4\text{Cl}_2 + 0.41\text{Hg}_2\text{Cl}_2 + 0.24\text{C}_2\text{H}_6 + 0.18\text{CH}_2 = \text{CHCl} + 0.15\text{C} + 0.07\text{C}_2\text{H}_6 + 0.02\text{H}_2 + 0.01\text{C}_2\text{H}_2$. A mechanism consistent with the experimental results at high pressures is given. From the effect of added CO_2 on the reaction, an approximate value of $\sigma^2 = 5.7 \times 10^{-16} \text{ cm}^2$ has been calculated for the quenching cross-section of methyl chloride. A.

541.14

4851. The mercury ($^3\text{P}_1$) photo-sensitized decomposition of propane at high temperatures. S. BYWATER AND E. W. R. STEACIE. *J. Chem. Phys.*, **19**, 319-25 (March, 1951).

The mercury ($^3\text{P}_1$) photo-sensitized decomposition of propane has been studied from room temperature to 450°C at pressures between 4 and 300 mm. The high temperature results are explained in terms of the decomposition of the propyl radical to form ethylene or propylene, and activation energies of 20 and 38 kcal, respectively, are assigned to these reactions. Experiments are also described where propane and propylene were in competition for hydrogen atoms, the relative rates of reaction being found at 3 temperatures. The difference in the activation energies of the two reactions is 4 kcal. The reactions at lower pressures are more complex and only a qualitative description of them can be given. A.

541.14

4852. The mercury ($^3\text{P}_1$) photo-sensitized reaction of ethane at high temperatures. S. BYWATER AND E. W. R. STEACIE. *J. Chem. Phys.*, **19**, 326-9 (March, 1951).

The mercury photo-sensitized decomposition of ethane has been carried out with particular emphasis on the high-temperature reaction. Evidence is given that under these experimental conditions the ethyl radical becomes unstable around 400°C. An activation energy of 39.5 kcal is assigned to the reaction $\text{C}_2\text{H}_5 = \text{C}_2\text{H}_4 + \text{H}$ on the basis of the proposed mechanism. A.

541.14/.15 : 539.16.08

Chemical method of radiation dosimetry. See
Abstr. 4631

541.146 : 541.124

4853. Determination of absolute rate constants for olefinic oxidations by measurement of photochemical pre- and after-effects. I. At "high" oxygen pressures. L. BATEMAN AND G. GEE. *Trans Faraday Soc.*, 47, 155-64 (Feb., 1951).

The theoretical equations are modified by important experimental correcting terms; these are discussed and a method of obtaining the required ratio of the constants without evaluating the corrections is described. The values of the constants for dihydromyrcene and ethyl linoleate thus obtained agree closely with those determined via the rotating sector technique. Oct-1-ene, digeranyl, gutta-percha and rubber have also been examined. See also Abstr. 1215 (1949). A.

DISPERSIONS . COLLOIDS . ADSORPTION

541.18

541.18 : 532.72

4854. Diffusion in chemical reaction processes and in the growth of colloid particles. F. C. COLLINS. *J. Coll. Sci.*, 5, 499-505 (Dec., 1950).

A theoretical treatment of the effect of variation in the probability of absorption of a molecule diffusing up to a sink upon the flux is given for both planar and spherical sinks. [See also Collins and Kimball, *J. Coll. Sci.*, 4, 425 (1949)]. R. F. BARROW

541.18.043

4855. Particle shape and the concentration dependence of sedimentation and diffusion. S. NEWMAN AND F. EIRICH. *J. Coll. Sci.*, 5, 541-9 (Dec., 1950).

A consideration of the motion of a particle in an ultracentrifuge from the Langevin equation shows that the concentration dependence of sedimentation should involve only the concentration dependence of the frictional coefficient. The coefficient K appearing in the expansion of the frictional coefficient, $F = F_0(1 + KC + \dots)$ has been evaluated from sedimentation data in the case of four fractions of polystyrene in methyl ethyl ketone, toluene and chloroform. K was found to be proportional to the square root of the molecular weight over the range investigated in the three solvents mentioned. The relationship between the concentration dependence of diffusion and K is briefly treated. A.

541.182

4856. The growth of uniform colloidal dispersions. H. REISS. *J. Chem. Phys.*, 19, 482 (April, 1951).

It is shown that an assembly of competing particles, growing by diffusion, develop the squares of their radii at equal rates. This condition provides a mechanism leading towards uniformity. A method, based on this equal square rule, is suggested for the

determination of size distributions in polydispersed systems. A.

541.182.025

4857. Particle shape in thixotropic suspensions. A. F. SIRIANNI, G. B. MOSES AND I. E. PUDDINGTON. *Canad. J. Chem.*, 29, 166-72 (Feb., 1951).

Several equations have been proposed that predict the shape of suspended particles when the viscosity of a suspension of known concentration is measured. These are not applicable to suspensions showing thixotropy, owing to the dependence of the measured viscosity on the shear rate used. However, by using viscosity values that have been extrapolated to infinite rate of shear, good agreement has been found between the predicted and measured shapes for particles in thixotropic systems, and the method appears to be suitable for submicroscopic particles. A scheme is also proposed for comparing the degree of thixotropy of different systems. A.

541.182.5 : 539.27

Direct observation of gel structure with the electron microscope. See Abstr. 4788

541.182.6

4858. Low temperature studies with colloidal silicic acid. J. F. HAZEL AND E. SCHIPPER. *J. Coll. Sci.*, 5, 532-40 (Dec., 1950).

Silica sols prepared with mineral acids and with ion-exchange resins have been frozen at -15° , -25° , -35° , -45° , -55° , -65° and -190°C . The effects of hydrogen-ion concentration, rate of thawing, temperature of ageing the frozen systems and presence of electrolytes were investigated. The following factors were found to increase the stability of the systems: (a) low temperature of freezing, (b) low temperature of ageing, (c) rapid rate of thawing, and (d) presence of LiCl and CaCl₂. A.

541.183

4859. Chemisorbed oxygen on charcoal and the sorption of strong inorganic bases and acids. J. H. WILSON AND T. R. BOLAM. *J. Coll. Sci.*, 5, 550-66 (Dec., 1950).

The hypothesis that the sorption by charcoal of strong inorganic bases from aqueous solution is due to the presence of chemisorbed water is found to be untenable. Sorption of base is probably due to the presence of chemisorbed O, which appears to form two types of complex, viz. an α -complex, in which 2 atoms, and a β -complex, in which 4 atoms of O are equivalent to 1 mol of sorbed NaOH. At temp. c. 400°C sugar (and hexadecabenzene) charcoal can fix large quantities of O, where possibly the whole is involved in the sorption of base. O chemisorbed on sugar charcoal does not form basic complexes, but strong inorganic acids are physically adsorbed on the C surface. There are 4 tables and 14 references.

H. H. HODGSON

541.183

4860. Structural model of low pressure "physical" adsorption. M. A. COOK, D. H. PACK AND A. G. OBLAD. *J. Chem. Phys.*, 19, 367-76 (March, 1951).

Describes a proposed new type of adsorption

potential associated with surface strain induced in the elimination of unbonded electron orbitals ("first-order strain"), and strain due to surface (chemical) heterogeneities, or surface impurities ("second-order strain"). These surface strains are assumed to give rise to a "semi-chemical" adsorbate-adsorbent attachment in the first layer of multimolecular films. This is termed "structural adsorption" and is considered to be largely responsible, along with ordinary van der Waal's potentials, for the low pressure region of the type II isotherm. The theory is applied in the calculation of the adsorption isotherms for pure N, pure O and mixtures of N and O on anatase. It is further applied in determining the composition of the adsorbate in mixed gas adsorption and in the computation of the surface pressure of these films over the entire range of relative pressures from zero to $p/p_0 = 1.0$. Excellent agreement with experimental observations is achieved. A.

541.183 : 531.724

4861. Kinetics of gas adsorption as a method of area determination. G. JURA AND R. E. POWELL. Letter in *J. Chem. Phys.*, **19**, 251-2 (Feb., 1951).

Observations are reported on the adsorption (a) of NH_3 on a silica-alumina cracking catalyst at 0°C , and (b) of H_2O at 25°C on anatase treated with Al_2O_3 , where the specific rates of adsorption decrease sharply with the completion of a monolayer. The values of surface area computed from the kinetic data are in good agreement with those computed from equilibrium data. H. H. HODGSON

541.183 : 532.614

4862. The role of surface tension in multilayer gas adsorption. W. G. MCMILLAN AND E. TELLER. *J. Chem. Phys.*, **19**, 25-32 (Jan., 1951).

The surface energy of the adsorbed phase is calculated by the use of a Fourier analysis of the surface configuration. This energy is then used in the calculation of the corresponding factor in the partition function, leading ultimately to an isotherm equation which includes the surface tension effect. This isotherm is compared with experiment, with the result that the surface tension effect alone is found to overcorrect the BET theory. A.

541.183 : 539.11

4863. Investigation on the adsorption of benzene vapours by active carbon black. M. M. DUBININ AND D. P. TIMOFEV. *Dokl. Akad. Nauk, SSSR*, **76** (No. 4) 555-8 (1951) *In Russian*.

An equation of the adsorption isotherm is deduced for the general case of adsorbents (active C) of a mixed structural type [cf. Dubinin and Zaverina, *Zh. Fiz. Khim.*, **23**, 1129 (1949)]. The equation is then applied to the results obtained with spherical-particle carbon black (Spheron Grade 6) in which the first structural type (relatively fine micropores) is being gradually developed by activation. The agreement between the observed and calculated adsorption values is very satisfactory in the relative-pressure range of from 5×10^{-6} to 0.6. The change of the equation constants with progressing activation gives some insight into the change in the C black structure. F. LACHMAN

CHEMICAL STRUCTURE 541.4/.6

541.53

4864. The valency state of manganese in the so-called "manganese dioxides." J. BRENET AND A. M. BRIOT. *C.R. Acad. Sci., Paris*, **232**, 726-7 (Feb. 19, 1951) *In French*.

Application of the formula MnO_2 to all the oxides which appear to have this composition is refuted by magnetochemical and crystallographic evidence, particularly in regard to the interpretation of catalyzed reactions and isotopic exchange reactions. W. R. ANGUS

541.57

4865. Hexavalent bond orbitals. IV. G. H. DUFFEY. *J. Chem. Phys.*, **19**, 92-3 (Jan., 1951).

Six equivalent bond orbitals of D_3 symmetry are set up. Application of the orthogonality and normalization conditions leads to solutions when the composition is $sp^{1+2m}d^{3-n-2m}$. The coefficients in the angular wave functions are expressed in terms of four parameters. The trigonal prism orbitals and the trigonal antiprism orbitals previously discussed can be obtained on assigning values to some of the parameters. A.

541.57

4866. An averaged field calculation of the polarity of the carbon-hydrogen bond. C. R. MUELLER AND H. EYRING. *J. Chem. Phys.*, **19**, 193-6 (Feb., 1951).

Considering the carbon-hydrogen bond as an isolated unit, and including the effect of the inter-electronic repulsions, a quantum-mechanical calculation of the polarity of this bond is made. The bond dipole is found to be C^+H^- . On the basis of these calculations, the effect of change in hybridization on the C-H dipole, and the similar effect of replacement of H in a hydrocarbon by a highly electronegative substituent, is qualitatively discussed. It is predicted that, in both cases, there will be a tendency for the dipole moment to reverse itself. A.

541.57

4867. The bonding of trihalide and bifluoride ions by the molecular orbital method. G. C. PIMENTEL. *J. Chem. Phys.*, **19**, 446 (April, 1951).

A simple molecular orbital treatment is presented to explain the bonding in trihalide ions, X_3^- , XY_2^- , and XYZ^- , and bifluoride ion, HF_2^- . The M.O.'s are formed from linear combinations of $np\sigma$ halogen orbitals, and the $1s$ hydrogen orbital and stable bonding M.O.'s are obtained without the introduction of higher atomic orbitals. Applications are suggested in prediction of other stable species and low energy reaction intermediates. A.

541.57

4868. Hexavalent bond orbitals. III. G. H. DUFFEY. *J. Chem. Phys.*, **18**, 510-12 (April, 1950).

See Abstr. 4238 (1950) for Part II.

541.57 : 539.132

4869. Estimated bond energies in carbon, nitrogen, oxygen, and hydrogen compounds. G. GLOCKLER. *J. Chem. Phys.*, **19**, 124-5 (Jan., 1951).

Estimates of bond energies of CC, CN, CO, NO, OO, NN, CH, NH and OH bonds are made on the

sis of the heat of sublimation of carbon [$L(C)$] being 36 eV and the heat of dissociation of nitrogen (N_2) = 11.80 eV].

A.

541.63

70. The stereochemistry of the imidazolidine ring. FISCHER. *J. Chem. Phys.*, **19**, 395 (April, 1951).

The electric moments of several imidazolidine derivatives in *p*-xylene solution have been measured at various temperatures. It is suggested that the substances are mixtures of geometrical isomers which in thermal equilibrium, the isomerism being due to the pyramidal arrangement of the valencies of the valent N. From the temperature dependence of the moments, the energy difference between the two postulated isomers is calculated to be about 6 kcal/mole.

A.

541.64 : 532.73

71. High polymer solutions. II. The osmotic pressures of polystyrene solutions. C. E. H. BAWN, R. F. J. FREEMAN AND A. R. KAMALIDDIN. *Trans Faraday Soc.*, **46**, 862–72 (Oct., 1950).

See Abstr. 8540 (1950) for Part I.

541.64 : 532.73

72. High polymer solutions. III. The relation between intrinsic viscosity and molecular weight for polystyrene fractions in benzene, toluene, chloroform, ethyl benzene and methyl ethyl ketone. C. E. H. BAWN, R. F. J. FREEMAN AND A. R. KAMALIDDIN. *Trans Faraday Soc.*, **46**, 1107–11 (Dec., 1950).

Measurements of the intrinsic viscosity of polystyrene fractions in 5 solvents at 25°C are in accord with the viscosity-molecular weight relationship $[\eta] = KM^\alpha$; α attains a limiting value of 0.73 in good solvents. The decrease in α as the solvent becomes poorer is accompanied by a corresponding increase in K and these two magnitudes are related.

A.

541.64 : 532.73

73. High polymer solutions. IV. The intrinsic viscosity-molecular weight relationships in mixed solvents. C. E. H. BAWN, T. B. GRIMLEY AND M. A. VAJID. *Trans Faraday Soc.*, **46**, 1112–20 (Dec., 1950).

The relation between the intrinsic viscosity and the molecular weight of polystyrene fractions (mol. wt. 2 000–1 600 000) in toluene-heptane and toluene-methyl alcohol mixed solvents, has been investigated. The relationship, $[\eta] = KM^\alpha$, was obeyed in all cases and with a constant value of α for any mixture. The value of α decreases in bad solvents reaching the value 0.73 at the precipitation point. A single relationship exists between α and K for all pure and mixed solvents examined. The theories of viscosity advanced by Debye and Bueche and by Kirkwood and Riseman are used to evaluate the influence of the solvent on the average dimensions of a polymer molecule. At constant molecular weight the "effective bond length" b , in the equation $R^2 = b^2Z$ (R^2 is the mean square displacement of the chain ends and Z the degree of polymerization) decreases in bad solvents, but at the precipitation point, b is independent of the nature of the precipitating mixture. The importance of the so-called "volume effect" of coiling chain molecules and the difficulties in the way of its detection by viscosity measurements is briefly discussed.

A.

541.64 : 532.73
4874. High polymer solutions. V. Effect of concentration on the viscosity of dilute solutions. C. E. H. BAWN. *Trans Faraday Soc.*, **47**, 97–100 (Jan., 1951).

The viscosity dependence on concentration of fractions of polystyrene obeys the relationship: $\eta_{sp}/c = [\eta] + k'[\eta]^2c$. The value of k' is independent of molecular weight (72 000–1 600 000) but increases rapidly as the solvent medium becomes poorer. It is shown that for two solvent-precipitant systems k' varies linearly with α , the exponent of the modified Staudinger equation.

A.

541.64 : 536.63

4875. Cohesion and degree of polymerization of large polystyrolene molecules according to their specific heats. LI-SHU-HUA. *C.R. Acad. Sci., Paris*, **232**, 821–2 (Feb. 26, 1951) In French.

Specific heats C are determined at 70°, 80°, 95°, 113° for 3 polymers of M.W. 55 000, 125 000, 425 000. In the case of the 1st polymer, a passage to a liquid state probably accounts for a C higher than that of the others at temperatures > 80°. J. JACOBS

541.68

4876. The central force model for additive molecular properties. H. J. BERNSTEIN. Letter in *J. Chem. Phys.*, **19**, 140–1 (Jan., 1951).

All nuclear interactions are included. The additive physical properties become parabolic functions of the no. of substituents in methanes.

J. JACOBS

LABORATORY APPARATUS 542.1/.7

542.1 : 666

4877. Glass as a material for apparatus in science and technology. H. REGLER. *Trans Instrum. Meas. Conf., Stockholm* (1949) 254–9 (1950) In German.

A general review of the use of glass-ware in the laboratory and in chemical industry. Glass filters, glass electrodes for pH measurements, distillation columns, etc., are described.

R. W. FISH

542.41

4878. Vacuum furnace for metal single crystals. D. LAZARUS AND D. R. CHIPMAN. Note in *Rev. Sci. Instrum.*, **22**, 211–12 (March, 1951).

CHEMICAL ANALYSIS 543/545

543.712/.812

4879. New apparatus for the estimation of moisture by the thermal principle. G. MUELLER. *Trans Instrum. Meas. Conf., Stockholm* (1949) 239–43 (1950) In German.

Discusses determination of moisture content by oven drying in air- and vacuum-ovens. Describes two drying ovens. The laboratory model operates at 105°C; air is circulated by a pump through the oven and two silica gel columns, the second of which contains gel with a colour indicator which shows when the

gel is becoming damp. The columns are regenerated in 1 hr, after each 60 hr use, by circulating air with the pump, using built-in heaters. The rapid tester uses tared metal pans heated by conduction from a hot plate, at 135°C, forming the base of a tunnel long enough to hold 3 pans. The insertion of a 4th pan pushes the 1st on to the pan of a built-in balance where it is weighed hot. The deflection-type balance is directly calibrated in moisture content from 0 to 25% in steps of 0.2%, for a 10 g sample. Three determinations are made every 10 min. C. F. BROCKELSBY

544.8 : 539.155.2

4880. Qualitative analysis from mass spectra. S. M. ROCK. *Analyt. Chem.*, **23**, 261-8 (Feb., 1951).

Presents several aids to qualitative analysis and outlines and illustrates various basic procedures: check of mass intervals to identify fragments and elements; use of peak-free regions to establish absence of fragments; comparison of peaks with those predicted from normal stable-isotope ratios; recognition of characteristic half-mass and metastable-transition groups; and use of mass spectral compilations such as those available from A.P.I. Project 44. A table of isotope contributions of hydrocarbons through C_7 is given. Peaks are roughly classified by magnitude and charted against mass in a summary of the spectra of 279 compounds. A.

545.372

4881. Influence of the frequency of the applied voltage at a dropping mercury electrode. Study of the cathodic oscillograph. M. FOURNIER AND M. QUINTIN. *C.R. Acad. Sci., Paris*, **232**, 834-6 (Feb. 26, 1951) *In French*.

When the applied voltage is varied in the polarograph method, it is found for different ions, e.g. Zn, Cd, etc., that the potential of the levels in the potential-time oscillogram does not vary as a function of the frequency of the applied voltage, but that the level widths are inversely proportional to the square root of the frequency, and diminish to zero for a limiting frequency which depends on the nature of the ion and of the solution. There are diagrams for Zn and Cd.

H. H. HODGSON

545.7 : 533.15

4882. Application of thermal diffusion to gas analysis. E. WHALLEY. *Trans Faraday Soc.*, **47**, 129-37 (Feb., 1951).

It should be possible to analyse three component gas mixtures by partly separating with a thermal diffusion column and measuring the properties of the mixtures obtained. The minimum sizes and the minimum equilibrium time of a thermal diffusion column required for a given separation are discussed theoretically, and it is shown that these have quite practicable values. A.

545.7 : 537.534

4883. Gas analysis with the use of a mass spectrometer. H. NEUERT. *Arch. tech. Messen, Issue No. 180 (Ref. V71-1) T4-5 (Jan., 1951) In German*.

Discusses the technical problems, utilization of results, and the uses of mass spectrometers in gas analysis. F. LACHMAN

545.8

4884. Dosage and localization of lithium by a nuclear reaction in minerals. E. PICCIOTTO AND M. VAN STYVENDAEL. *C.R. Acad. Sci., Paris*, **232**, 855-7 (Feb. 26, 1951) *In French*.

Li-bearing materials are either loaded into photographic plates by solution, or a thin slice of solid material is placed adjacent to the emulsion and irradiated in an intense slow neutron flux. The triton tracks from the reaction $Li^6(n, \alpha)H^3$ are counted, the neutron flux being monitored by counting the protons from $N^{14}(n, p)C^{14}$ reaction. Concentrations of 10^{-6} to 10^{-7} g Li/g may be measured to 10% by the solution method and 10^{-5} g Li/g to 10% by the solid method, with a slow neutron flux of 10^{12} n/cm².

B. ROSE

545.8 : 539.155.2

4885. Analysis of solids with the mass spectrometer. J. C. GORMAN, E. J. JONES AND J. A. HIPPLE. *Analyt. Chem.*, **23**, 438-40 (Feb., 1951).

The aim was to develop a method whereby the spark source could be used in an instrument employing electrical recording. A method of compensating for fluctuations in the source is illustrated in the determination of the Ni and Cr content of 6 stainless steels. The results agree well with the composition determined chemically. A.

545.822

4886. The step-sector in spectrochemical analysis. R. E. THIERS. *J. Opt. Soc. Amer.*, **41**, 273-6 (April, 1951).

Experiments were performed to discover whether or not the use of the step-sector is a valid method of film calibration for spectrochemical analysis. It was found for the films tested, viz., Eastman Spectrum Analysis No. 1, Spectrum Analysis No. 2, I-L, 103-F, I-N and III-F, that the calibration curve was a valid one if the sector was run at speeds greater than about 40 flashes per exposure. Schwarzschild coefficients were calculated for the above films under the conditions of the experiment. A.

545.824 : 535.3 : 537.531

X-ray spectroscopy with bent crystals. See Abstr. 4411

545.827 : 537.563

Mass spectra of hydrocarbons containing D and C¹³. See Abstr. 4483-4

545.828

4887. Some notes on spectrochemical technique. J. GILLIS AND J. ECKHOUT. *Meded. K. Vlaamse Acad. Wetensch. Belg.*, **11** (No. 9) 20 pp. (1949) *In Dutch*.

A current of air passing between the electrodes scatters the vapours produced by the discharge, and introduces errors in spectrochemical analysis unless the air current is symmetrical with respect to the electrodes. Hollow electrode carriers for producing a symmetrical vertical air current are described. Schmidt's echelon-type logarithmic sector [*Rec. Trav. Chim. Pays-Bas*, **62**, 437 (1943); Abstr. 2316 (1947)] can be used with an intermittent source only with compact solid electrodes, and is unsuitable for the analysis of powders or of a solution evaporated on a graphite electrode. A new technique, involving

specially-shaped electrodes, is described in detail for the analysis of powders using a spark or intermittent arc discharge. The reproducibility of the results is comparable with that obtained with compact solid electrodes.

J. GRANT

545.828

4888. Supplementary notes on the use of the echelon-type logarithmic sector in spectral analysis, in combination with a rapidly intermittent light source. J. GILLIS AND J. EECKHOUT. *Meded. K. Vlaamse Acad. Wetensch. Belg.*, **11** (No. 12) 10 pp. (1949) In Dutch.

Stroboscopic effects readily visible to the naked

eye are apparent when the logarithmic sector rotates very rapidly, but satisfactory standardization curves are obtained for spectrochemical analyses of solutions of steels when the exposures are long enough, and when the rate of rotation of the sector is synchronized with the intermittent arc. Special difficulties encountered with solutions of clays necessitate the use of a slowly rotating sector. The points on the blackening curve obtained with 3 successive exposures, using the high-speed rotating sector and a normal exposure time, fall on the same line if a continuous arc is used, but diverge from it for a spark discharge and to a greater extent for an intermittent arc.

J. GRANT

CRYSTALLOGRAPHY 548

548.0

4889. Light figures of zinc crystals. M. YAMAMOTO AND J. WATANABÉ. *Sci. Rep. Res. Inst. Tôhoku Univ., Ser. A*, **2**, 81–95 (Feb., 1950).

Light figures were observed on the three principal crystallographic planes {0001}, {1120} and {1010} of zinc crystals, which were etched for various time-intervals with variously concentrated aqueous solutions of various acids, alkalis and salts. The suitability of observed figures for determining orientations of Zn crystals with the light-figure method was examined, and light figures obtained by etching for 20 min with boiling saturated aqueous solution of KOH was found to be the most suitable for the perfect determination (the determination of all angles which the geometrically predominated axis of a crystal makes with the hexagonal axis and diagonal axes of the first or second kind).

A.

548.0

4890. Orientation determination of zinc crystals by the light-figure method. M. YAMAMOTO AND J. WATANABÉ. *Sci. Rep. Res. Inst. Tôhoku Univ., Ser. A*, **2**, 270–9 (April, 1950).

The application of the light-figure method to the determination of orientations of zinc single crystals was studied thoroughly. This technique of orientation determination may be conducted with the simple apparatus and procedure and with high precision within $\pm 0.1^\circ$, of which full accounts are given with reference to various examples of actual orientation determinations.

A.

548.33

4891. Polymorphism of RbBr. L. G. SCHÜLZ. Letter in *J. Chem. Phys.*, **19**, 504 (April, 1951).

RbBr grown from solution on oriented Ag films has a CsCl type structure with a lattice constant of $4.08 \pm 0.02\text{\AA}$.

J. A. FRANKS

548.5

4892. The surface energy of small nuclei. G. C. BENSON AND R. SHUTTLEWORTH. Letter in *J. Chem. Phys.*, **19**, 130–1 (Jan., 1951).

A two-dimensional close-packed structure, and a three-dimensional cluster of 13 molecules are used to illustrate why and to what extent the surface energy depends on the curvature. This treatment is appropriate to small nuclei.

C. TURNER

548.5

4893. The shaping of metal crystals. P. R. ROWLAND. *Trans Faraday Soc.*, **47**, 193–4 (Feb., 1951).

A method is described for growing metal single crystals from the melt in shapes such as spheres, flat strips, mechanical test pieces, etc., suitable for chemical and physical examination. A simple technique is described for preparing a flat surface parallel to a given crystal plane.

A.

548.5

4894. Growth of single crystals of tin from the melt, A. J. GOSS AND S. WEINTROUB. *Nature, Lond.*, **167**, 349–50 (March 3, 1951).

The results of tests on 108 rods, 15–25 cm long, of 99.997% pure Sn, which were crystallized *in vacuo* from the melt under controlled conditions of temperature gradient, G , and rate of growth, R , are described. Andrade and Roscoe's travelling furnace method [*Proc. Phys. Soc., Lond.*, **49**, 152–76 (March, 1937)] was used with speeds of travel ranging from 0.5 to 20 mm/min. The temperature of the rods, as determined by a thermocouple embedded in a dummy specimen, was recorded continuously and was correct to within 1°C . The rods, after crystallization, were carefully examined, imperfections noted and the crystalline structure determined by means of a specially designed optical goniometer. The forms of crystals obtained for the various speeds and values of G used are listed. For crystals grown at speeds ≤ 5 mm/min the angle between the rod axis and the c -axis was always 70 – 90° . At higher speeds greater scatter was obtained. It is stated that there does not appear to be any relation between G , or G/R , and the resultant crystal orientation.

S. WEINTROUB

548.5 : 539.27

Observation of spiral growth—steps in n -paraffin single crystals in the electron microscope. See Abstr. 4790

548.538 : 539.164.93

4895. The formation of microcrystals on crystalline surfaces irradiated by Po alpha-radiations. L. WIENINGER AND N. ADLER. *S.B. Öst. Akad. Wiss., Abt. IIa*, **158** (No. 6–10) 321–5 (1950) In German.

It is established that the irradiated strongly coloured areas of NaCl crystals have numerous microcrystals in the regions of strongest colour. The microcrystals

are doubly refracting and have been identified as NaNO_3 . It is considered that the α -rays in air lead to NO_2 formation which ultimately produces NaNO_3 . The microcrystals are oriented on the surface of the NaCl . Analogous results are reported for KCl crystals, the overgrowth of which is found to consist of oriented KNO_3 microcrystals, together with a small percentage of isotropic pyramids. Investigation on KBr shows unexpected anomalies not yet explained. Fluorite and calcite produced doubly refracting microcrystals, presumably $\text{Ca}(\text{NO}_3)_2$, but this is not yet established.

S. TOLANSKY

548.572

4896. Laminations in type II diamonds. J. F. H. CUSTERS. *Research, Lond.*, **4**, 131-6 (March, 1951).

A fractographic study has been carried out on a cleavage face of a type II diamond (ultraviolet transparent type). A number of cleavage patterns is reproduced which show both the characteristics of type I structures intrinsic to the crystal and type II or "hackle" structures intrinsic to the system of stresses producing cleavage. From the type I patterns it is concluded that this type II diamond is intensely laminated. The lamellae run parallel to (111) planes. Their spacing is about 1 micron, but higher values up to 10 microns were also found. A new set of lamellae not described in previous literature was detected. The traces of these lamellae in a (111) plane were found to run parallel to a direction of the form $\langle 123 \rangle$, the lamellae themselves being coincident with planes of one of the forms such as $\{120\}$, $\{211\}$, $\{031\}$ or $\{302\}$ which belong to one of the zones of form $\langle 123 \rangle$.

A.

MOLECULAR AND X-RAY CRYSTALLOGRAPHY 548.7

548.7

4897. On the extension of the nearest neighbour assumption in the theory of the superlattice and the intermetallic compound. H. SATO. *Sci. Rep. Res. Inst. Tôhoku Univ., Ser. A*, **1**, 405-10 (Dec., 1949).

An extension of present theoretical concepts to the case where the interaction potential V depends on the degree of order.

E. P. WOHLFARTH

548.7

4898. On order parameters. M. J. KLEIN. *Amer. J. Phys.*, **9**, 153-62 (March, 1951).

The problem of describing the state of order in a binary alloy is considered. A set of order parameters is defined in the following way: p_i is the probability that if a given site is occupied by a B atom then a site which is its i th neighbour is occupied by an A atom. The relationships of this set to the parameters used by other authors are discussed.

A.

548.7

4899. On the possible identity of rhombohedral and orthorhombic graphite. J. S. LUKESH. Letter in *J. Chem. Phys.*, **19**, 383-4 (March, 1951).

548.7 : 536.7

4900. Some theorems on the free energies of crystal surfaces. C. HERRING. *Phys. Rev.*, **82**, 87-93 (April 1, 1951).

Although the interpretation of experiments in such fields as the shapes of small particles and the thermal etching of surfaces usually involves problems of kinetics rather than mere equilibrium considerations, it is suggested that a knowledge of the relative free energies of different shapes or surface configurations may provide a useful perspective. This paper presents some theorems on these relative free energies which follow from the Wulff construction for the equilibrium shape of a small particle, and some relations between atomic models of crystal surfaces and the surface free energy function used in this construction. Equilibrium shapes of crystals and of non-crystalline anisotropic media are classified, and it is pointed out that the possibilities for crystals include smoothly rounded as well as sharp-cornered forms. The condition is formulated for thermodynamic stability of a flat crystal face with respect to formation of a hill-and-valley structure. A discussion is presented of the limitations on the applicability of the results imposed by the dependence of surface free energy on curvature; and it is concluded that these limitations are not likely to be serious for most real substances, though they are serious for certain idealized theoretical models.

A.

548.7 : 537.226.2

4901. Polarizabilities of ions in perovskite-type crystals. S. ROBERTS. *Phys. Rev.*, **81**, 865-8 (March 1, 1951).

Each type of ion is shown to have very nearly the same polarizability in different crystals of the perovskite type as well as in the diagonal cubic types reported previously. This conclusion is based on dielectric constant data for several titanates and zirconates and KMgF_3 . The values of ionic polarizability are roughly proportional to the cube of the radius for ions in the same valence series.

A.

548.7 : 539.133

4902. The electronic energy levels of molecular crystals. H. WINSTON. *J. Chem. Phys.*, **19**, 156-60 (Feb., 1951).

The electronic energy levels of a molecular crystal are classified according to representations of the space group of the crystal. When the ground state of the free molecule is totally symmetric, the number of crystal levels active in the absorption of light can be determined by a simple rule. Applications to rare earth crystal spectra and to the crystalline benzene spectrum are discussed.

A.

548.73 : 534.39

Some effects of vibration on X-ray diffraction by crystals. See Abstr. 4208

548.73/.74 : 539.26/.27

X-ray and electron investigation of materials. See Abstr. 4784-91

548.733

4903. A radiocrystallographic installation with demountable tube. A. GUINIER. *Trans Instrum. Meas. Conf., Stockholm* (1949) 65-70 (1950) In French.

Gives a technical description of the "Cristallobloc."

with 6 anticathodes, that can be changed while the tube is working, and of two diffraction chambers and a special chamber for use with a curved crystal.

C. TURNER

548.733 : 535.42 : 537.531

The application of Geiger counters in X-ray diffraction. See Abstr. 4415

548.733 : 537.531

4904. Note on crystals suitable for double crystal X-ray spectroscopy in the region 3 to 15 Å. S. T. STEPHENSON AND D. L. MARTIN. Note in *Rev. Sci. Instrum.*, 21, 1023-4 (Dec., 1950).

548.734 : 518.5

4905. The use of punched cards in molecular structure determinations. IV. Approximations to the temperature factor. M. E. JONES AND V. SCHOMAKER. Letter in *J. Chem. Phys.*, 19, 511-12 (April, 1951).

Abstr. 6165 (1950), Part III.

548.734.84

4906. On the theoretical effect of absorption in the specimen and of experimental conditions on the homogeneity of Debye-Scherrer lines, using a divergent beam. C. STORA. *C.R. Acad. Sci., Paris*, 232, 222-4 (Jan. 15, 1951) In French.

Discusses the conditions under which there will be a distinguishable satellite line due to diffraction of X-rays from the back of a cylindrical specimen.

A. R. STOKES

548.735

4907. A new type of X-ray scattering. K. DAS GUPTA. Letter in *Nature, Lond.*, 167, 313-14 (Feb. 24, 1951).

Experimental verification, using several insulating crystals, of theory given previously. See Abstr. 1492 (1951).

A. R. STOKES

548.736.1 : 536.413

4908. High temperature structure and thermal expansion of some metals as determined by X-ray diffraction data. I. Platinum, tantalum, niobium, and molybdenum. J. W. EDWARDS, R. SPEISER AND H. L. JOHNSTON. *J. Appl. Phys.*, 22, 424-8 (April, 1951).

The crystal structure and thermal expansion of Pt, Ta, Nb and Mo have been determined between 1 100° and 2 500°K. These metals were found to undergo a uniform thermal expansion over the temperature

range of this investigation and to undergo no structural change. The permanent elongation of Ta wires, produced by annealing at temperatures between 2 473° and 2 773°K, appears to be caused by re-orientation of crystal grains in the specimen and to preferred direction of crystal growth during annealing, rather than to a change in crystal structure. Quadratic equations have been developed for the thermal expansion of Pt, Ta, Nb and Mo. Values of the expansion coefficient α were computed for each of the metals by differentiating these equations.

A.

548.736.3

4909. Crystal structure of CuMg₂. K. SCHUBERT AND K. ANDERKO. *Naturwissenschaften*, 38 (No. 2) 46 (Jan., 1951) In German.

The cell of Westgren *et al.* [$a = 5.273$, $b = 9.05$, $c = 18.21$ kX, $Z = 16$] is confirmed. Orthorhombic, $F2dd$, all atoms in 16(b) with co-ordinates: Cu $\frac{1}{4}$, $\frac{1}{4}$, $\sim \frac{1}{2}$; Mg I $\frac{1}{2}$, 0, $\sim \frac{1}{2}$; Mg II $\frac{1}{2}$, $\sim \frac{1}{2}$, 0. A. J. C. WILSON

548.736.5

4910. The crystal structure of NaPt₃O₄. J. WASER AND E. D. MCCLANAHAN, JR. *J. Chem. Phys.*, 19, 413 (April, 1951).

The structure of a microcrystalline Pt compound is derived from X-ray data. Space group $O_h^2 - Pm3n$, $a_0 = 5.69$ Å, with 6 Pt at $\pm (\frac{1}{4} 0 \frac{1}{2}, \frac{1}{2} 0 \frac{1}{2})$, 8 O at $\pm (\frac{1}{4} \frac{1}{4} \frac{1}{4}, \frac{1}{4} \frac{1}{4} \frac{1}{4}, \frac{1}{2} \frac{1}{2} \frac{1}{2})$ and 2 Na at (000, $\frac{1}{2} \frac{1}{2} \frac{1}{2}$), corresponding to the formula NaPt₃O₄. The co-ordinations are as follows: platinum 4 O and 2 Pt, oxygen: 3 O and 2 Na, sodium: 8 O. The substance is an ionic conductor.

A.

548.737

4911. Variation of the crystallinity of polyethylenes as a function of the temperature. J.-J. TRILLAT, S. BARBEZAT AND A. DELALANDE. *J. Rech. Cent. Nat. Rech. Sci.*, No. 13, 176-82 (1950) In French.

A sample of polyethylene of molecular weight about 15 000 was placed in a hole 0.2 cm in diameter in an Al plate 0.07 cm thick. The plate was heated electrically, and the X-ray diffraction pattern registered photographically at a series of temperatures from 20° to 120°C. The fraction of non-crystalline material was estimated from the corrected intensities (measured photometrically) of the diffuse band at 12° 24' and the crystalline rings 110 at 13° 36' and 200 at 15° 10'. It increases from 27% at 20°C to 44% at 80°C, 77% at 115°C and 100% at 120°C.

A. J. C. WILSON

GEOPHYSICS 55

550.381

4912. New views on the cause of the permanent magnetic field of the earth. H. HAALCK. *Geofis. Pura Appl.*, 18 (No. 1) 132-42 (1950) In German.

Theoretical considerations show that a rotating cosmic body, at a high temperature and strongly ionized, possesses a magnetic field due to the Brownian movement of the free electrons. It is assumed that the main part of the geomagnetic field (the Kernfeld) arises from this effect. The remaining part (Rindenfeld) is attributed to two electric current systems flowing in the earth's crust, a clockwise system round the American continent and an anti-clockwise one

between Africa and Australia. These systems are related to the two major geosyncline zones of the earth, and are apparently generated by causes associated with geotectonic processes. The secular variation represents the gradual changes of these earth currents.

A. T. PRICE

551.24 : 523.34

4913. The theory of direct contraction. I. RUUD. *Avh. Norske Vidensk Akad. Oslo. I. Mat.-Nat. Kl.*, No. 2, 28 pp. (1949).

The theory explains the formation of mountain chains, continents and oceans on the earth by the

effects of contraction of the solid crust and the resultant tangential strains. It is suggested that the lunar craters and maria are caused by similar forces. Photographs are given showing resemblance between strain-produced deformations in plastic materials and lunar ring mountains.

A. C. CLARKE

ATMOSPHERE . METEOROLOGY 551.5

551.501.4 : 551.594

4914. New measurements of the atmospheric electric field by a glider. R. LECOLAZET. *Ann. Géophys.*, **5**, 84-6 (Jan., 1949) In French.

The author describes a method for obtaining continuous and detailed measurements of variations in the vertical component of the electric atmospheric field by means of an apparatus, consisting of a single thread electrometer and a barograph installed in a glider.

METEOROLOGICAL ABSTRACTS

551.508.77 : 621.387.424 : 621.317.083.7

4915. Telemetering system for radioactive snow gage. J. A. DOREMUS. *Electronics*, **24**, 88-91 (Feb., 1951).

For predicting hydro-electric and irrigation water supplies from watersheds it is important to know the amount of winter snowfall in inaccessible mountain districts. The necessary measurement is made by means of a radioactive isotope Co_{60} — $\frac{1}{2}$ -life 5.3 yr—located at the bottom of a heavy lead pipe sunk in the ground and a Geiger-Müller (G.M.) tube mounted 15 ft above. The amount of radiation penetrating the snow and reaching the G.M. tube is a measure of the precipitation with an accuracy within 5%. Each alternate pulse from the G.M. tube shifts the frequency of an a.f. sub-carrier while the intermediate pulses restore it. The sub-carrier in turn frequency-modulates a 169-173 Mc/s carrier, the output of which is transmitted to a repeater station. From there it is retransmitted to a recording station. The G.M. counting rates range from 20 000 to 120 per min, the latter figure being the background rate, and to improve accuracy a counting period of 5 min is used. The count rate can be divided down, say by 8, to reduce the final required bandwidth to 1 kc/s. Different a.f.'s and r.f.'s are used at the various data-transmitting stations to feed the common repeater station so that the combined information can be sent on to the recording station simultaneously on one r.f. carrier. Power-supply provision and station structure are described.

H. G. M. SPRATT (R)

551.508.9

4916. An "electrical nose" for the continuous observation of atmospheric aerosols. K. H. STEHBERGER. *Dtsch. Wetterdienst US-Zone, Ber.*, No. 12, 171-6 (1950) In German.

The presence of floating particles decreases the conductivity of air proportionately to the number of particles per unit volume and their mean surface area. An instrument is described and illustrated, consisting of two large cylindrical condensers in a differential

circuit, to measure the difference of conductivity of unfiltered and water-filtered air. Curves of diurnal variation are reproduced. METEOROLOGICAL ABSTRACTS

551.508.93 : 551.521.6

4917. On the photometry of sky light. H. LOSSNITZER AND H. PERSON. *Dtsch. Wetterdienst US-Zone, Ber.*, No. 12, 112-16 (1950) In German.

Relative measurements of zenith light were made with photo-elements combined with colour and polaroid filters, giving spectral distribution and polarization. Very small spectral regions were examined with interference filters and electronic amplification. Observations extended into twilight. Results shown in a number of graphs.

METEOROLOGICAL ABSTRACTS

551.510.41

4918. A determination of the vertical distribution of atmospheric ozone by the aid of lunar eclipses. H.-K. PAETZOLD. *Z. Naturforsch.*, **5a**, 661-6 (Dec., 1950) In German.

Measurements of the distribution of brightness in the vicinity of the shadow boundary at partial lunar eclipse have been obtained by photographic photometry. From these, the stratospheric distribution of O_3 is deduced, max. concentration obtaining at 22 km. Above this altitude, O_3 concentration drops rapidly, a negligible amount appearing above 40-50 km. The observations also point to the presence of an unidentified weak blue-absorbing layer, situated between 100-200 km.

D. R. BARBER

551.510.41

4919. The absence of atmospheric ethylene. J. H. SHAW AND H. H. CLAASSEN. Letter in *Phys. Rev.*, **81**, 462-3 (Feb. 1, 1951).

The solar spectrum in the region near 950 cm^{-1} has been remapped at Columbus, Ohio, and compared with laboratory spectra of the band of ethylene. No sign of the ethylene fine structure was found on the solar spectra at this point and it practically coincides with one of the most intense CO_2 lines. If, therefore, ethylene exists in the atmosphere the amount must be very small.

R. S. READ

551.510.535

4920. Sporadic E movements. N. C. GERSON. *Geofis. Pura Appl.*, **18** (No. 1) 162-9 (1950).

Details of a preliminary co-operative experiment made in June 1949 by radio amateurs in which the horizontal movement of sporadic E ionization has been traced. On a particular night, estimates of the geographical extent of the ionization indicated an area of about 500 000 km^2 with an average horizontal velocity of about 190 to 260 km/hour.

W. J. G. BEYNON

551.510.535

4921. Echoes from the D- and F_2 -layers on a frequency of 21 Mc/s? E. GHERZI. Letter in *Nature, Lond.*, **167**, 412 (March 10, 1951).

551.510.535 : 538.566.3

Radio-wave propagation in the ionosphere. See Abstr. 4558-60

551.510.535 : 621.396.11

4922. Investigations of the spreading of sky-waves. W. BUDDE. *Z. Naturforsch.*, 5a, 683-7 (Dec., 1950) In German.

Short account of measurements made in 1944-45 of elevation and azimuth determinations on short waves (9.83 Mc/s) reflected by the ionosphere. In addition to rapid short period variations, a diurnal variation in the great circle deviations was established, which could be attributed to tilting of the ionosphere.

W. J. G. BEYNON

551.510.535 : 621.396.11

4923. An investigation of certain properties of the ionosphere by means of a rapid frequency-change experiment. B. H. BRIGGS. *Proc. Phys. Soc., Lond. B*, 64, 255-74 (March, 1951).

An apparatus is described in which a receiver is kept in tune with a sender by means of automatic frequency control circuits operated by the direct pulse from the sender. The tuning is corrected by each pulse and remains fixed for the time between pulses. A frequency range of 1 Mc/s can be covered in 1 sec and may be selected anywhere in the range 2-20 Mc/s. A number of applications of the apparatus are described and typical records are reproduced. The irregularities of ionization present in the normal regions are investigated by the observation of the irregular variations of the amplitude of the reflected wave which are produced when the frequency is altered. Irregularities of ionization are sometimes found to be localized in height. Observations of the reflection coefficient of the abnormal region *E* suggest that there are two distinct types of region, one an irregular region consisting of scattering clouds, the other a coherent layer with a thickness of the order of 5 km. The apparatus is also used to study the behaviour of the subsidiary critical frequencies often present below the main critical frequency of region *E*. It is found that these are always decreasing in critical frequency whenever they are observed. Records of amplitude and group path near the critical frequency of a region can be used to determine the collision frequencies of electrons. The treatment is mainly descriptive (full discussion later).

A.

551.511

4924. Comment on the global energy balance of the atmosphere. J. VAN MIEGHEM. *Centen. Proc. Roy. Met. Soc.* (1950) 173-5.

An expression is obtained for the total energy flux of the equatorial belt between latitude ϕ and $-\phi$. Certain terms in this complete expression have hitherto been neglected, but this is shown to lead to contradictory conclusions. It is considered, therefore, that all terms in the global energy balance should be carefully computed.

R. S. READ

551.513

4925. The experimental determination of the thermal state of the lower stratosphere. R. M. GOODY. *Centen. Proc. Roy. Met. Soc.* (1950) 9-18.

Some recent experiments upon the measurement of solar spectra from a high-flying aircraft are described, and some preliminary results upon the water-vapour content of the stratosphere are given. The possibility of total radiation flux measurements is discussed and

it is shown that such measurements would be of great interest but might be rather insensitive. Lastly, the possibility of measuring turbulent heat transfer in this region is considered and it is shown that although the direct approach is very difficult, there are several possibilities available for the collection of indirect evidence.

A.

551.513

4926. Some aspects of the general circulation of the atmosphere. S. PETTERSEN. *Centen. Proc. Roy. Met. Soc.* (1950) 120-55.

On the basis of present knowledge of the zonal distribution of incoming and outgoing radiation and of the criteria for dynamic stability of the zonal motion, the conclusion is reached that the radiative processes, in tending to establish radiative equilibrium, create dynamic instability which gives rise to meridional circulations that contribute to the exchange of heat and atmospheric properties. A generalization of the vorticity theorem is derived and the vorticity budget of the atmosphere discussed. It is shown that the frictional and the nonadiabatic thermal components of the vorticity sources and sinks must balance for each global isentropic sheet, but local balance cannot, in general, be attained. The theoretical results are compared with a statistical analysis of the behaviour patterns of the cyclones and anticyclones of the northern hemisphere during the period 1899-1939, and agreement in all essential features is found.

A.

551.513

4927. The cause of the general circulation of the atmosphere. E. T. EADY. *Centen. Proc. Roy. Met. Soc.* (1950) 156-72.

From earlier work on the stability of baroclinic motion it is concluded that the mean flow is always unstable and must continually generate turbulence. The mechanism by which instability is continually re-established, and turbulent flow consequently maintained, is described and its intimate relation to the observed heat transfer deduced. The transfer of angular momentum is a secondary feature associated with the "constraints," to which the complete set of equations and boundary conditions are equivalent, which modify the form of the overturning process represented by the growth of turbulent disturbances. The hypothesis that the vertical component of absolute vorticity is conserved is rejected both for theoretical reasons and because it leads to incorrect results in middle latitudes. It is suggested, however, that this hypothesis may be valid for approximate calculations near the poles and near the equator because the motion is more nearly barotropic. Transfer behaviour in middle latitudes is deduced from a consideration of the structure of growing disturbances. The mechanism of surface friction effects is considered.

A.

551.513

4928. The average planetary circulation in vertical meridian planes. A. H. R. GOLDIE. *Centen. Proc. Roy. Met. Soc.* (1950) 175-87.

Describes average conditions in the atmosphere from the equator to pole to a height of 45 km, so far as they can be inferred from observations. It is

deduced that there are two (or more) major vertical circulations, one above the other, running in opposite senses in meridian planes. The nature of the circulations which should be set up by convection in an atmosphere unequally heated in different latitudes is then discussed theoretically. Dynamical reasons are suggested for the phenomenon of the stratosphere and for the height scale of the tropopause in middle latitudes and at the equator respectively. A.

551.513

4929. Centenary symposium on atmospheric turbulence. *Centen. Proc. Roy. Met. Soc.* (1950) 249–53.

P. A. Sheppard gave equations which can be used to obtain information regarding transport and structure using integrals of products of turbulent fluctuations. Reference was made to instruments for recording atmospheric turbulent fluctuations and of a mechanical computer to evaluate integrals of their products. H. Charnock stated that the aim was to filter the observed variations into high and low frequency components and to express the statistical properties of the faster in terms of the slower components. The results of a determination of the energy spectrum of the temperature fluctuations over Lough Neagh were shown. O. G. Sutton referred to his prediction of temperature fluctuation decrease with height according to the law $\sqrt{(T'^2)} \propto z^{2/3}$ where z = height, and this was verified by the Lough Neagh observations. J. R. D. Francis showed that there were kinks in the wind velocity profiles between 1 m and 3 m above water level. A modification of the usual "rough surface" boundary layer theory is required to find what shear stress exists at the surface. N. N. Faegri showed that long-distance pollen transport can be used to give a rough indication of the large-scale vertical atmospheric turbulence. R. S. READ

551.515 : 621.396.82

4930. Results of more recent measurements of atmospheric interference with radio reception, chiefly on 9 Mc/s. H. K. BENDER. *Dtsch. Wetterdienst US-Zone, Ber., No. 12*, 161–6 (1950) In German.

Three methods of recording are described. Diurnal variation of static and influence of thunderstorms and fronts are discussed and a possible effect of penetrating cosmic rays considered. No connection was found with reflection or damping in the ionosphere.

METEOROLOGICAL ABSTRACTS

551.521

4931. The emission spectra of the earth's surface, the troposphere, and the lower stratosphere. A. ADEL. *Centen. Proc. Roy. Met. Soc.* (1950) 5–8.

Simultaneous observations of the i.r. emission spectra of the earth's surface, the troposphere, and lower stratosphere have been obtained at Flagstaff, Arizona (1941), and Alamogordo, New Mexico (1948). In conjunction with atmospheric absorption spectra they lead, via simple calculations, to the effective radiative temperatures of the ozone and nitrous oxide layers: O_3 , $-40^\circ C$; NO , $+5^\circ C$. A.

551.524

4932. Two notes on temperature changes in the troposphere due to radiation. G. D. ROBINSON. *Centen. Proc. Roy. Met. Soc.* (1950) 26–33.

The radiative temperature of short grass in cloud-

less conditions differs substantially from the temperature of the air near the surface. This makes possible considerable radiative exchange. Three specific cases are examined and the radiative flux changes between the surface and 50 cm investigated, using the Kew chart. Radiative flux changes between the surface and 500 mb are computed for a cloudless June day, using the Elsasser chart. The resulting heat loss, summed over the 24 hr, is shown to be approximately compensated by the heat gain due to convection at the surface.

551.524.3

4933. Annual and diurnal temperature variations in the upper atmosphere. H. WEXLER. *Tellus*, 2, 262–74 (Nov., 1950).

An attempt is made to determine the annual and diurnal variations of temperature to a height of 80 km by knitting together available observations and theoretical results. The observations include radiosonde data, meteor-determined densities, V-2 rocket observations, anomalous propagation of sound, and infrared spectroscopy. The theory most heavily relied upon is the radiative computation made by Gowan. For the annual temperature range there is reasonably good agreement between theory and observations, such that in the upper ozonosphere (30 to 55 km), summer temperatures are higher than winter temperatures by amounts as large or larger than those at the surface. As in lower levels, the annual temperature range aloft increases with latitude. For the diurnal temperature variations there is a large disagreement between the computations of Gowan and Penndorf. However, available evidence appears to favour Gowan's computations, which, together with other considerations, indicate a diurnal temperature range of the order of 10 to $15^\circ C$. A.

551.524.34

4934. Temperature trends of the past century. H. C. WILLETT. *Centen. Proc. Roy. Met. Soc.* (1950) 195–211.

The trend, from analysis of records, is found to be significantly upward since about 1885, but by no means uniformly so in all parts of the world. The upward trend is most pronounced in the higher middle and polar latitudes of the northern hemisphere, but apparently negative in the polar latitudes of the southern hemisphere. The geographical patterns of winter and annual mean trends of temperature by 20-year periods since 1880 are analysed and briefly discussed, together with the trend graphs from a few selected stations. It appears that fluctuations in the intensity and position of the winter polar anticyclones over the North American and Eurasian continents are the most distinctive features of the general circulation pattern indicated by the 20-year temperature changes. A.

551.524.34

4935. On the interpretation of climatic variations as revealed by a study of samples from an equatorial Atlantic deep-sea core. C. D. OVEY. *Centen. Proc. Roy. Met. Soc.* (1950) 211–28.

Preliminary results of a study of the variation in sea-surface temperature from counts of planktonic foraminifera in an equatorial Atlantic deep-sea core

show that climatic changes can be detected from the topmost 55 cm of core. A determination of the amount of error in counting was made and was found to be small. Temperature changes, as indicated by temperate and warm-water foraminifera, appear to bear a direct relationship to the CO_2 content of the samples. A.

551.571.7

4936. Some measurements of the distribution of water vapor in the stratosphere. E. W. BARRETT, L. R. HERNDON, JR AND H. J. CARTER. *Tellus*, 2, 302–11 (Nov., 1950).

The results of three high-altitude ascents of an experimental radiosonde incorporating an electronic dew-point hygrometer and carried by a large plastic balloon are presented. Significant features of the moisture distribution in the stratosphere revealed by these flights include at least one saturated layer in the vicinity of the tropopause on each occasion, and marked increases of the mixing ratio with height in the layer between 16 and 30 km in the two summer soundings. Charts and tabulations of the data from the three soundings are presented. A.

551.576

4937. Structure of shower clouds. F. H. LUDLAM. *Nature, Lond.*, 167, 254–6 (Feb. 17, 1951).

The conditions for convective cloud precipitation resulting from the growth of liquid droplets of minimum radius $30\ \mu$ in the cloud base without intervention of the ice phase are discussed. Notice is given of future quantitative examination of precipitation development in cloud models with varying initial updraught, top and base temperature, size of droplets introduced, and concentration and efficiency of ice nuclei. W. C. A. HUTCHINSON

551.576.1

4938. Some remarks on the study of the micro-physics of natural clouds. H. DESSENS. *Centen. Proc. Roy. Met. Soc.* (1950) 59–60.

The instability of cloud droplets throws doubt on some of the methods used for their measurements. In particular, the capture of droplets on fine threads yields reliable results only if the droplets are photographed immediately after their capture. This requires a microcinematograph technique which has also been applied to the study of the freezing of supercooled droplets and of the presence of ice crystals in supercooled clouds. A.

551.578

4939. Physics of clouds and precipitation. G. M. B. DOBSON. *Centen. Proc. Roy. Met. Soc.* (1950) 34–6.

Reference is made to the theories of Bergeron and Findeisen on the formation of rain and the seeding of clouds by ice particles or ice-forming nuclei. Laboratory and other observations have shown that supercooled water clouds are common at temperatures down to -15°C , but ice only is present below -41°C . A chain reaction by splintering of ice particles occurs when some ice-forming nuclei are introduced into a cloud. R. S. READ

551.578

4940. The effects produced by seeding supercooled clouds with dry ice and silver iodide. V. J. SCHAEFER. *Centen. Proc. Roy. Met. Soc.* (1950) 42–50.

A summary is provided of the many experiments carried out at the summit of Mt. Washington and in various parts of U.S.A. and elsewhere of project CIRRUS to obtain information relating to seeding of clouds and the conditions existing in the clouds before and after seeding. Photographs of some cloud tests show the clear lanes, the fall of rain or snow from clouds, and optical effects, produced by seeding. R. S. READ

551.578

4941. Electrical coalescence of fog and clouds. M. PAUTHENIER. *Centen. Proc. Roy. Met. Soc.* (1950) 60–1.

A summary of work shows that to precipitate a normal fog by seeding with neutral water droplets of radius $10^{-3}\ \text{cm}$, 660 kg of water/ $10^4\ \text{m}^2$ must be used. For charged droplets 6 kg of water/ $10^4\ \text{m}^2$ is required. Such an application is possible because of the very large disruptive electrical field of small droplets, but otherwise there would be a discharge between the charged spherical particle and the neutral fog or cloud droplet with the very strong charges used. For a thick fog account must be taken of the increase of the radius of the charged droplet as it falls through the fog. R. S. READ

551.578

4942. On the freezing of droplets of water and of aqueous solutions. C. LAFARGUE. *Centen. Proc. Roy. Met. Soc.* (1950) 61–6.

Droplets of radius 1 to $10\ \mu$ of water and solutions of various concentrations were observed to freeze at about -41°C in air or other media. Surface tension is apparently unimportant and cooling of droplets by immersion in oil or "silicone" appears justified. The method is especially suitable for the study of cloud and rain droplets. The freezing of droplets at -41°C seems to be a molecular property of water itself unless some freezing nucleus is effective at this temperature.

In the discussion on this paper and those reported in preceding Abstr., H. P. Palmer referred to the ejection of small splinters of ice as water freezes and to the production of small splinters of ice from growing hoar frost and tests made of both methods. Splintering occurs when crystal growth is dendritic but not when solid hexagonal prisms form. A. W. Brewer referred to relatively dirty air in CuNb clouds causing an increased rate of crystal growth. E. W. B. Gill described experiments on the electrification produced when water droplets are blown against ice and rebound. J. A. Prins referred to a similarity in the delayed freezing of small Hg drops. R. S. READ

551.578.4

4943. The formation of ice crystals and snowflakes. B. J. MASON. *Centen. Proc. Roy. Met. Soc.* (1950) 51–8.

The growth of an ice crystal from the vapour is discussed in terms of the new dislocation theory, the

linear rate of growth being calculated as a function of ice-supersaturation, temperature and vapour pressure. An attempt is made to account for the various forms of ice crystals which predominate under given conditions, particular consideration being given to the transition from polyhedral to dendritic growth. The influence of the fall motion of the crystal on its growth form is discussed, and the coagulation of individual crystals into snowflakes is briefly considered.

A.

551.583.1

4944. On the present climatic variation. L. LYGGAARD. *Centen. Proc. Roy. Met. Soc.* (1950) 206–11.

Changes in temperature and pressure normals in recent years show a rise of temperature in arctic and north temperate zones, the rise being greatest in the north. Pressure is lower in winter over the northern N. Atlantic and higher in the southern N. Atlantic and over land areas. In January the west wind is more dominant in western Europe and south Scandinavia and there is increased transport of Atlantic air masses into Europe.

R. S. READ

551.583.2/3

4945. On the value of palaeoclimatological evidence. K. FAEGRI. *Centen. Proc. Roy. Met. Soc.* (1950) 188–95.

A review is made of such factors to show climatic change as snow lines, fossil distribution and the effect of summer and winter temperature limits on survival and growth, glacial movements and the effects of temperature and precipitation, measurements from tree rings, soil patterns in permanently frozen soil, and organisms and their dependence on vegetation and fauna. The pitfalls in these methods are discussed. It is concluded that it is necessary to establish the circulation patterns of former periods to obtain more reliable results.

R. S. READ

551.591.1 : 551.575

4946. Propagation of visible and infra-red radiations through fog. M. J. BRICARD. *Centen. Proc. Roy. Met. Soc.* (1950) 36–42.

Tests were made on the transparency of fog in a closed tank using a Hg vapour lamp and measuring the mass of water per unit volume and the drop-size distribution curve for the fog. Good agreement with theory was obtained. An extension of wavelength to the range $0.4\text{--}5.5\mu$ was next made and used with an artificial fog and in a StCu cloud at the summit of the Puy de Dôme. Diameters of drops in the fog were determined by microphotography after being caught on thin fibres. The optical density or transparency is found to be constant in all parts of the spectrum. Small particles may, however, cause a greater transparency in the long wavelengths.

R. S. READ

551.593.12 : 537.312.5

4947. Photo-electric observations of the scintillation of stars. H. E. BUTLER. Letter in *Nature, Lond.*, 167, 287–8 (Feb. 17, 1951).

Records of stellar scintillation have been obtained using a photo-multiplier tube and a cathode-ray oscilloscope. Sample records for various stellar elevations show that the frequency of scintillation

varies from 50 to 400 c/s with increasing elevation. The observations indicate that both the r.m.s. amplitude and the frequency vary from night to night and even during the course of a single night. See also Megaw, Abstr. 2219 (1951).

W. J. G. BEYNON

551.593.12 : 551.513

4948. Spectrum of atmospheric turbulence. L. F. RICHARDSON AND E. C. S. MEGAW. Letter in *Nature, Lond.*, 167, 318 (Feb. 24, 1951).

Comment on earlier letter by Megaw [Abstr. 2219 (1951)] calling attention to published work on atmospheric turbulence, with reply by Megaw.

W. J. G. BEYNON

551.593.5

4949. Special regions of the sky with respect to the scattering of light. E. V. PIASKOVSKAYA-FESSENKOVA. *Astron. J., USSR*, 27 (No. 4) 243 (1950) In Russian. English Abstr. in *Astron. News Lett. [Harvard] No. 55*, 12–13 (Feb. 15, 1951).

This paper considers the surface brightness of different points, all lying on the sun's almucantar, but at different angular distances from the sun. As the sun rises, the surface brightness of such a point, at fixed angular distance, passes through a maximum. From the curves thus obtained it is possible to deduce certain properties of the phase function. It is shown that the maximum brightness $B = 4.782 (\sigma/k)f(\theta)$ still, depends only upon $(\sigma/k)f(\theta) = \mu/k$. In the Rayleigh type of scattering $\sigma/k = (3/16)\pi$, and for the isotropic case $\sigma/k = \frac{1}{2}\pi$. The final results list the quantity $a = 16\pi(\mu/k)$ obtained from the observations at values of θ between 10° and 140° , and these are compared with the theoretical values resulting from Rayleigh's law and from the law of isotropic scattering. The atmosphere scatters very much in accordance with Rayleigh's law in the interval $60^\circ \leq \theta \leq 90^\circ$; and also like the isotropic scatterer for $\theta \sim 60^\circ$.

551.593.55

4950. Light of the night sky; effect of latitude. P. ABADIE, A. VASSY AND E. VASSY. *Ann. Géophys.*, 5, 157–63 (Feb., 1949) In French.

This is a study of the probable mechanism of excitation of the light of the night sky and the altitude at which it originates. In order to avoid the disturbing influence of auroral activity the authors have measured, at low latitudes, the distribution of the intensity of the light of the night sky for the bands 5 577 and 6 300Å. The observations indicate that this phenomenon can be explained by assuming the existence of a single ionospheric layer, whose altitude decreases regularly from 1 000 km at the beginning of the night to 400 km at 3 a.m.

METEOROLOGICAL ABSTRACTS

551.594.13

4951. Review of the literature on the ion balance of the lower atmosphere since 1939. W. D. PARKINSON. *Int. Ass. Terr. Magn. Elect. Bull.*, No. 13, 307–12 (1950).

The review deals with the results obtained on the equation of small ion balance, the effect of atmospheric pollution, the electrode effect and space charge, values

the several parameters, nature of the condensation nuclei, the slow ion "mobility spectrum," the time and space distribution of condensation nuclei and the factors of ionization in the ion balance of the atmosphere. Finally the possible effect of atomic ions on atmospheric electric elements is mentioned.

R. S. READ

551.594.12

52. Meteoric ionization. P. M. MILLMAN. *J. Roy. Astron. Soc., Can.*, **44**, 209-21 (Nov.-Dec., 1950).

A general discussion of the properties of the ionization produced in the upper atmosphere by meteors produced from radar methods of observation, including reference to some unpublished results of Millman and McKinley.

M. W. OVENDEN

551.594.13

53. The mobility of the small ions of the atmosphere at Poona. K. S. AGARWALA. Letter in *Indian J. Met. Geophys.*, **2**, 63-5 (Jan., 1951).

A summary of the results obtained during 1935-37 by simultaneous measurements of the conductivity and ion-content using an Ebert ion-counter and a Herdian apparatus at 10 a.m., Indian Standard Time. The monthly means ranged from 113-80% of the annual mean of $1.06 \text{ cm}^2 \text{ volt}^{-1} \text{ sec}^{-1}$ for the positive ions and from 111-80% of the annual mean of $0.09 \text{ cm}^2 \text{ volt}^{-1} \text{ sec}^{-1}$ for the negative ions.

J. M. HOUGH

551.594.51

54. Continued investigations on the excitation functions of nitrogen bands. H. FOSS AND L. VEGARD. *Norsk Vidensk. Akad. Oslo. I. Mat.-Nat. Kl.*, No. 4, 14 pp. (1949).

Excitation-energy functions for the 1st pos., 2nd pos. and neg. groups of N bands have been redetermined experimentally, and the results extended to

exciting potentials up to 470 V. The bands of the 2nd pos. group do not appear on spectrograms corresponding to the higher potentials, between 300 and 470 V. The present measures are in good agreement with those previously made by Rypdal and Vegard (1939). The excitation process in the auroral region may well be fundamentally different from that observed in the laboratory because, in the upper atmosphere, the relative conc. of atomic N may be much greater.

D. R. BARBER

551.594.51

4955. Protons and the aurora. C. W. GARTLEIN. Letter in *Phys. Rev.*, **81**, 463-4 (Feb. 1, 1951).

The H α spectral line shift to violet measured during a moderate aurora indicates a proton mean approach velocity of 675 km/sec. See Abstr. 4002 (1951).

W. C. A. HUTCHINSON

551.594.6 : 523.165 : 621.396.11

4956. Fluctuations in the intensity of radio waves from galactic sources. C. G. LITTLE AND A. MAXWELL. *Phil. Mag.*, **42**, 267-78 (March, 1951).

It has been shown previously that the fluctuations in the intensity of radio energy from the galactic sources have a local terrestrial origin. This paper describes further observations of the two most intense sources, in the constellations of Cygnus and Cassiopeia, taken over a wide range of angles of elevation. At high angles the radio fluctuations are shown to be correlated with the occurrence of "spread" ionospheric echoes from the F region. When the sources are low on the northern horizon fluctuations are always observed; these are probably introduced by the passage of radio waves through the continuously disturbed ionospheric regions at high magnetic latitudes. Spaced receiver observations taken over base lines of 0.1, 4 and 11 km enable the scale of the radio energy diffraction pattern across the ground to be determined.

A.

BIOLOGY 57/59

591.11

57. Continuous recording of circulatory hemoglobin. A. C. GUYTON, W. M. GILLESPIE, JR AND E. G. ARMSTRONG. *Rev. Sci. Instrum.*, **22**, 205-9 (March, 1951).

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612.1 : 539.16

4958. The mathematical basis of the interpretation of tracer experiments in closed steady-state systems. C. W. SHEPPARD AND A. S. HOUSEHOLDER. *J. Appl. Phys.*, **22**, 510-20 (April, 1951).

The basic equation for the mixing of radioactive isotopes is $dR/dt = I \text{ grad } a$, where dR/dt is the flux of radioactivity; a , the relative specific activity; and I , the interdiffusion constant. The equation is applied to systems of compartments and some electrical analogies are presented. As special cases of the unconstrained

systems treated in an earlier paper [Abstr. 1143 (1948)] two constrained systems are discussed in which only a single radioactive isotope is required for the study of transport phenomena. One of these (mammary system) consists of a central compartment communicating with a number of peripheral compartments. In the other (catenary system) the compartments are arranged chainwise. Equations are derived for the n -compartment mammary system relating the time dependent specific activities of the compartments to the exchange rates between the peripheral and central compartments and to their content of substance being exchanged. In analysing the effect of lumping of a series of compartments into a single equivalent one the case where the exchange rates cluster about a mean is discussed in some detail. In the catenary system the greater mathematical difficulties are indicated including the fact that the results depend on the order of the compartments. It is pointed out that in mammalian physiological experiments observations confined to only one compartment such as the circulating blood are insufficient for a complete analysis. A.

612.2
4959. An automatic manometric respirometer. P. R. MORRISON. *Rev. Sci. Instrum.*, **22**, 264-7 (April, 1951).

612.843.32
4960. Visual sensitivity to surface color differences. H. R. DAVIDSON. *J. Opt. Soc. Amer.*, **41**, 104-11 (Feb., 1951).

Several sets of data on visual sensitivity to colour differences are now available. All of these data, however, have been obtained using optical arrangements differing from those employed in practical colour matching. Data on visual sensitivity to colour differences on textiles under ordinary viewing conditions have been obtained in this study to check the validity of the previous data for practical use. Observations were made by four professional colourists on a red, a blue and a green series of wool dyeings. Each series contained about 20 samples, and each sample was judged independently against a standard 3 times by each observer. Since dyers' terminology was used, a means of conversion to I.C.I. notation had to be developed. The MacAdam ellipses are found to be a good representation of visual sensitivity to chromaticity differences under common viewing conditions, providing these ellipses are taken to represent a difference somewhat larger than a least perceptible difference rather than the $\frac{1}{3}$ L.P.D. reported by MacAdam. Visual sensitivity to differences in apparent luminous reflectance is found to be about 0.1 Munsell value steps, or considerably poorer than that which has previously been reported. A.

612.843.6
4961. Visual acuity through various types and grades of sun glasses. R. H. PECKHAM. *J. Opt. Soc. Amer.*, **41**, 23-7 (Jan., 1951).

The visual acuity of 27 subjects was determined with a new psychometric device and compared with their visual acuity when looking through three types of sun glasses prepared by grinding and polishing the lens to curvature, by bending polished plate glass, and by bending drawn sheet glass. No significant effect between the different types was discovered. The visual acuity of 43 other subjects was similarly determined and compared to their visual acuity while looking through three grades of resolving power in sun glasses made by the process of bending drawn sheet glass. No significant effect of the different optical resolving powers was found. It is concluded that no presently employed method of manufacturing sun glasses has, in itself, any superiority with regard to sharpness of seeing. A.

612.843.611
4962. The effect of varying the light-dark ratio of intermittent pre-exposure upon subsequent dark adaptation in the human eye. F. A. MOTE AND A. J. RIOPELLE. *J. Opt. Soc. Amer.*, **41**, 120-4 (Feb., 1951).

The course of dark adaptation was followed after pre-exposure to both intermittent and continuous light. The variable under investigation was the influence of the light-dark ratio of the intermittent pre-exposure. The rate of intermittence was 1 c/s and

four light-dark ratios were used: 1/2-1/2, 1/4-3/4, 1/8-7/8 and 1/16-15/16. The intensities of pre-exposure were: 8 860, 886 and 88.6 mV. At the lowest intensity no differences were found between any of the intermittent and their continuous control pre-exposures. At the two higher intensities the curves for the intermittent procedures were different from the control procedures and the differences were related to the light-dark ratios. It was found that, on the whole, the shorter the amount of light-time in the ratio the lower was the initial dark adaptation threshold, the greater the difference between the experimental and control curves throughout the course of dark adaptation, and the shorter the time elapsing before the appearance of the first colourless (rod) threshold stimulus. A.

612.843.611
4963. Dark adaptation level and duration of testflash. E. WOLF AND M. J. ZIGLER. *J. Opt. Soc. Amer.*, **41**, 130-3 (Feb. 6, 1951).

Using a testfield subtending a visual angle of 5 degrees, dark adaptation functions were obtained with 6 test-exposures (1.0, 0.5, 0.1, 0.04, 0.02 and 0.01 sec) both from the central retina and from the temporal parafovea. The functions for both retinal locations were found to vary systematically in relation to duration of testflash. With increasing test-exposure time the final cone levels as well as the final rod levels are at lower threshold brightnesses. The sensitivity for a given test-exposure time is greater in the central retina than in the parafovea for the photopic range of vision, whereas the sensitivity for the scotopic range is greater in the parafovea than in the central retina. A.

621.843.613
4964. Suprathreshold area brightness relationships. R. M. HANES. *J. Opt. Soc. Amer.*, **41**, 28-31 (Jan., 1951).

Size-brightness relationships have been studied at 4 intensity levels (0.1, 1.0, 10.0 and 100.0 ml for five different stimulus sizes (9, 18, 36, 72 and 144 min of visual angle). The test situation was such as to approximate an applied situation where there is little control over physical conditions. At the lower levels apparent brightness was found to increase with increasing area, i.e. the luminance of the larger stimulus was less than that of the smaller when the two were judged to be of equal brightness. At the higher levels, on the other hand, apparent brightness decreased with increasing area for 6 out of 8 observers. These 2 deviants showed a tendency in the same direction and might have exhibited the same effect if greater intensities had been used. A.

612.843.615 : 535.241.44
4965. Brightness relationships for comfortable seeing. S. K. GUTH. *J. Opt. Soc. Amer.*, **41**, 235-44 (April, 1951).

Quantitative data were obtained to determine the effects of sources of brightness. The results are based upon subjective appraisals of sources exposed to view in a controlled manner amid a surrounding field of uniform brightness. The criterion involved the visual sensation at the borderline between comfort

and discomfort. Certain factors may be considered as being basic and fundamental and include the brightness and size of the source and the brightness to which the eyes are adapted. Other factors which have a modifying influence upon the basic factors include the position and number of sources in the visual field and the configuration of the sources. The relationships among these factors are expressed by an empirical formula which makes possible the determination of the brightness conditions which should be expected to produce a comfortable visual sensation. A simple rule is developed for converting a group of sources into a single equivalent source. Close agreement is obtained between the observed and calculated brightnesses at the borderline between comfort and discomfort of a simulated visual environment.

A.

612.844.24

4966. Microfluctuations of accommodation of the eye and visual acuity for natural pupil diameters. A. ARNULF, O. DUPUY AND F. FLAMANT. *C.R. Acad. Sci., Paris*, **232**, 349-51 (Jan. 22, 1951) *In French*.

Calculation of the limits of resolution in minutes of arc for the human eye from data for the known aberrations of such an eye led to values which were less than those determined experimentally with a Foucault test object Contrast I. Small fluctuations of accommodation could account for the failure to realize experimentally the calculated resolution. With a point source subtending 0.33 min of arc, variations of shape and size of the retinal image can be noticed subjectively. Since these variations are much reduced by a feeble mydriatic they were thought to arise in the lens system of the eye and to indicate the presence of microfluctuations of accommodation. No discussion of small eye movements has been undertaken.

L. C. THOMSON

612.844.24

4967. Microfluctuations of the eye and their influence on the retinal image. A. ARNULF, O. DUPUY AND F. FLAMANT. *C.R. Acad. Sci., Paris*, **232**, 438-40 (Jan. 29, 1951) *In French*.

The extent of the retinal diffusion image has been measured both by photography and by a direct method and found to be approximately 2 min of arc. This value is in satisfactory agreement with that derived from the results of a coincidence method for measuring variations in the refraction of the eye, the principle of which has been used by Ivanoff for measuring the eye's spherical aberration. The disturbance of the retinal image produced by these microfluctuations go far to close the gap between the experimentally determined resolution of the eye and that calculated from a consideration of spherical and chromatic aberration only.

L. C. THOMSON

612.845

4968. Spherical and chromatic aberration and visual resolving power. M. FRANÇON. *Rev. Opt. (Théor. Instrum.)* **30**, 71-80 (Feb., 1951) *In French*.

Results obtained by Ivanoff [Abstr. 2738 (1947)] are used to show that in daylight vision the spherical

and chromatic errors of the eye are negligible as compared with its physiological limitations. Spherical aberration is small under all conditions, and does not interfere with the formation of a precise image. Chromatic aberration, also negligible at small pupil diameters, ω , becomes noticeable when $\omega \simeq 5$ mm. The influence of inhomogeneities in the ocular media is discussed in connection with the formation of point-images. Graphs are shown.

R. A. WEALE

612.845.1

4969. A study of night myopia. M. KOOMEN, R. SCOLNIK AND R. TOUSEY. *J. Opt. Soc. Amer.*, **41**, 80-90 (Feb., 1951).

High-contrast grating test objects were used. Night myopia first appeared at the brightness level where rod vision began to take place and grew larger as the brightness was further reduced. At the lowest brightness investigated, the myopia attained a value of 1.5 to 2.0 diopters, depending upon the observer. Night myopia appeared when accommodation was prevented by an optical method and also when accommodation was paralyzed with homatropine. It was therefore concluded that accommodation was not a significant cause of night myopia in the observers examined. All tests showed that night myopia, and its dependence upon the brightness level, is primarily a result of undercorrected spherical aberration of the eye. For some eyes, homatropine reduced night myopia slightly, but only to the extent that it reduced the spherical aberration. A review of the literature is included.

A.

612.85

4970. The behaviour of audibility thresholds at medium altitudes. G. LIVREA AND L. CAMPANELLI. *Atti Accad. Naz. Lincei (R.C. Cl. Sci. Fis. Mat. Nat.)* **9**, 389-95 (Dec., 1950) *In Italian*.

A study of five subjects has shown an increase of hearing sensitivity at the altitude of 1 800 m.

L. PINCHERLE

612.85

4971. The coarse pattern of the electrical resistance in the cochlea of the guinea pig (electroanatomy of the cochlea). G. v. BÉKÉSY. *J. Acoust. Soc. Amer.*, **23**, 18-28 (Jan., 1951).

This paper tries to show that for parts of the cochlea near the two windows the cochlear tube (consisting of the two scalae and the cochlear duct) can be considered electrically as a transmission line. The characteristic values of this transmission line are measured for different distances from the windows. In this way, a start has been made toward the development of a type of electroanatomy. The impedance values of the cochlear partition are important for determining the electrical energy losses in the cochlea.

A.

612.85

4972. Microphonics produced by touching the cochlear partition with a vibrating electrode. G. v. BÉKÉSY. *J. Acoust. Soc. Amer.*, **23**, 29-35 (Jan., 1951).

The basilar membrane is more sensitive to displacement in the radial direction than in the direction

perpendicular to its plane. The important question is whether microphonics are produced by a constant stationary displacement or whether they are produced only during the movement of the cochlear partition. With the aid of trapezoidal waves it was possible to show that in a fresh cochlear preparation only the static displacement produces the microphonic voltage. A single displacement of the basilar membrane produces a static voltage lasting for several seconds. This fact has an important bearing on the energetics of the microphonics. Preliminary experiments suggest that the same technique may be used for the inner parts of the cochlear partition. A.

614.8

4973. Results and analysis of various modes of action of radiation on some biological systems. W. HUBER. *Naturwissenschaften*, 38 (No. 2) 21-9 (1951) In German.

An impulse generator (capacitron) generating cathode rays of energy $2\frac{1}{2}$ MeV is used for irradiation of micro-organisms, viruses, enzymes, proteins and vitamins. Dosage, in r.e.p. units, is measured calorimetrically, and the mean lethal dose is tabulated and compared with the values for X-rays as well as α , β , γ , and neutron radiations, taken from other publications. The results are discussed in terms of the target theory, and some effects of temperature and environment are given.

F. T. FARMER

614.8

4974. Biological hazards of atomic energy. *Nature*, **London**, 167, 335-8 (March 3, 1951).

Conference held at the Royal Institution, London, October, 1950, aiming at an assessment of the social and biological risks today involved. Four sessions were held: (1) on biological and clinical effects of nuclear radiations, including the varying damage sustained by cells in absorbing the same amount of energy delivered from different radiations; (2) on tolerance levels and protection; details were given of stray radiation received by personnel at Harwell; optimism, and also doubt, were expressed over the acceptance of the present "maximum permissible dose"; (3) on implications of previous sessions, and the long-term genetical hazard; it was thought that, though present levels of general radiation were unlikely to jeopardize the future of the species, stray radiation should be minimized by every reasonable precaution; (4) on problems and responsibilities which may arise from the future use of atomic power.

D. V. MABBS

615.84

4975. Physical principles of ultra-short wave therapy and other high-frequency applications. K. HIGASHI. *Monogr. Ser., Res. Inst. Appl. Elect.*, No. 1, 7-19 (1950).

The characteristics of h.f. absorption in any material (biological or physical) are the inner and selective heating. It follows from Debye's theory of polar molecules that there is no proper frequency at which max. absorption occurs. Pätzold's theory of the absorption-frequency relation is unfounded and wrong. Point heat theories (Kowarschik; Awaya)

are disproved on the ground that energy dissipation around a spherical particle is proportional to the volume of the particle. A new theory of selective heating discusses the differential heating of an ellipsoidal particle (general case) in a medium. It is found that some of the h.f. characteristics also apply for l.f. in the case of elongated particles lying with their main axis in the direction of the electric field. As particles of colloidal size have the same temperature as the surrounding medium, h.f. energy is not bactericidal. The effect of dipole rotation in a therapeutical h.f. field is almost negligible. No specific action has been discovered without ambiguity, although specific action is not denied on principle.

W. SUMMER

615.84

4976. Electric conductive and dielectric studies on animal tissue with special reference to blood and red cells. Y. IWASE. *Monogr. Ser., Res. Inst. Appl. Elect.*, No. 1, 21-8 (1950).

Biological effects in a h.f. field are assumed to be due to specific phenomena more than to thermal phenomena. In the experiments the frequency ranged from 1 kc/s to 300 Mc/s. Frequency dependence is greater in the brain, liver and lung than in other tissues. The specific effect in blood is a function of the red cell concentration and apparent in both l.f. and h.f. regions. Between 30 kc/s and 15 Mc/s very high values for the dielectric constant (several thousand) were found. The anomalous dispersion frequencies for blood are 300 kc/s and 3 Mc/s. The dielectric constant at 300 Mc/s is 70 to 30, which is lower than for water. At 300 Mc/s Debye's type of dispersion in blood becomes apparent.

W. SUMMER

615.849

4977. Practical physical aspects in the use of radioactive cobalt 60 as a radium substitute. I. MESCHAN, R. R. EDWARDS AND P. J. ROSENBAUM. *Amer. J. Roentgenol. Radium Ther.*, 65, 255-64 (Feb., 1951).

The γ -roentgen equivalence of Ra and Co⁶⁰ is stated to be: Ra (filtered by 0.5 mm Pt): Co⁶⁰ (filtered by 0.23 mm hyperchrome steel) equals 0.84 : 1.3. Dosage tables for Co⁶⁰, modified from those of Paterson and Parker, and incorporating this ratio, are given for single plane implants up to 400 cm² in area and for treating distances up to 5.0 cm. A sample calculation is included. The encasing of irradiated Co wire, 1 mm dia., in commercial hyperchrome steel tubing, is described; the wall thickness to exclude primary β -rays, and its effect on the γ -rays, are indicated. A comparator method for standardization of Co⁶⁰ sources is given. Appended is a table showing decay of Co⁶⁰ during periods up to 50 years.

D. V. MABBS

616-7

4978. A new apparatus for the partitioning of expired air. J. H. U. BROWN, T. F. HATCH AND K. M. COOK. *Rev. Sci. Instrum.*, 22, 81-3 (Feb., 1951).

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771.3

4979. Photographic sharpness and resolving power. II. The resolving-power cameras in the Kodak Research Laboratory. F. H. PERRIN AND J. H. ALTMAN. *J. Opt. Soc. Amer.*, **41**, 265-72 (April, 1951).

The optical-reduction method of impressing images on emulsion samples for measuring the resolving power of the latter is preferred over the contact-printing method, chiefly for its practical convenience. A description is given of a camera containing a 150 mm *f*/5 apochromatic telescope objective, which makes 13 exposures to incandescent light on a power-of-two time scale. For materials of high resolving power, another camera is described that accommodates microscope objectives and makes 7 exposures to monochromatic light on any desired time scale. This camera uses distance pieces to position the sample, and the technique of using such pieces is discussed. The methods of making test objects and the precautions required are described. A.

771.4 : 778.37

4980. A new flash illumination unit for ballistic photography. H. F. QUINN AND O. J. BOURQUE. *Rev. Sci. Instrum.*, **22**, 101-5 (Feb., 1951).

A description is given of a flash illumination source of very high peak intensity which has been recently developed in this laboratory for use in conjunction with Kerr cell and image convertor type cameras. The electrical circuit of the unit permits 3 standard commercial flash tubes of the Egerton type to be operated simultaneously using only one energy storage capacitor, one trigger circuit and a single high voltage power supply. A comparison is made between the circuit of the present unit and those of previous flash illumination sources particularly with regard to (a) peak flash intensity, (b) effective flash duration, (c) efficiency of conversion of the total stored electrical energy into useful light output, and (d) reliability of triggering. Possible modifications of the present unit to enable it to be used as a flash source in the conventional "open shutter-single flash" photographic technique are discussed. A.

771.534.1

4981. Energy transfer in the photo-sensitization of silver halide photographic emulsions: optical sensitization, supersensitization, and antisensitization. W. WEST AND B. H. CARROLL. *J. Chem. Phys.*, **19**, 417 (April, 1951).

The theory of supersensitization and antisensitization is discussed and experimental evidence supporting the conclusions is furnished in detail, including correlations between optical sensitization and supersensitization with the type of absorption spectrum of the adsorbed dye; the relations between the concentration of sensitizer, supersensitizer, and antisensitizer, and the efficiency of super- and antisensitization; the quenching of fluorescence of sensitizers by both types of perturbing molecules; and effects of nonplanar dyes on the photoconductivity of optically sensitized silver halide emulsions analogous to their photographic effects. A.

771.534.5

4982. A densitometer which records directly in units of emulsion exposure. W. N. BROWN, JR AND W. B. BIRTLEY. *Rev. Sci. Instrum.*, **22**, 67-72 (Feb., 1951).

The recording microdensitometer described herein incorporates a device, termed a function transformer, which automatically and continuously converts densitometer deflection values to exposure values, and two pen and ink recorders. One recorder produces a direct exposure trace, while the other records the usual densitometer trace. An integrator permits the integrated exposure to be evaluated for any desired portion of the plate or film. The apparatus described can be used with any film or plate to which a suitable calibrating exposure has been applied and over the area of which the characteristic curve is sufficiently uniform. A.

771.534.5 : 621.317.39

4983. A direct-reading equivalent densitometer. A. F. THIELS. *J. Soc. Mot. Pict. Televis. Engrs*, **56**, 13-22 (Jan., 1951).

The definition of equivalent density of a primary colour of a multilayer colour film is given and a direct-reading photoelectric equivalent densitometer is described. The method of operation of the instrument is explained and the basic features of the electronic circuit and the optical and mechanical layouts are given. The apparatus has made it possible to make direct measurements of the density of any one primary colour of a colour film without being affected by the presence, if any, of other primaries. A.

771.534.55

4984. Photographic granularity and graininess. V. A variable-magnification instrument for measuring graininess. L. A. JONES AND G. C. HIGGINS. *J. Opt. Soc. Amer.*, **41**, 41-52 (Jan., 1951).

See Abstr. 2640 (1948) for Part IV. An instrument has been built to measure graininess in terms of the reciprocal of the blending magnification of an image of the sample as viewed by binocular vision from a constant distance. This instrument is essentially an autofocus variable-magnification projector which forms an image of constant size and of a luminance which is proportional to the transmittance of the sample. The image is formed on a rear-projection screen which is part of the front wall of a special observation room. The blending magnification may be determined either by permitting the observer to vary the magnification continuously until graininess is just perceptible, or by the experimenter varying the magnification discontinuously and presenting the enlarged image of the sample to the observer at 10 predetermined magnifications and having the observer judge only whether or not graininess is perceptible at each magnification. With the latter method, the image at each of the predetermined magnifications is repeatedly presented to the observer in a random order and the frequency of perception of graininess at each magnification of the image is plotted as a function of magnification. From this psychometric function the blending magnification is determined as that magnification at which the observer has perceived graininess during 50% of the observations. A.

771.534.55

4985. Photographic granularity and graininess. VI. Performance characteristics of the variable-magnification graininess instrument. L. A. JONES AND G. C. HIGGINS. *J. Opt. Soc. Amer.*, **41**, 64-75 (Feb., 1951).

Data obtained with the variable-magnification graininess instrument described in Part V (preceding Abstr.) are given showing the variation of graininess as a function of the luminance of the test field, the luminance of the various components of the observer's field, the viewing distance, and the angular subtense of the test field. On the basis of these data, standard conditions for the various variables are established for the measurement of graininess. Graininess measurements in terms of blending magnification at a constant viewing distance are compared with graininess measurements in terms of blending distance at a constant magnification. A.

771.535

4986. Herschel effect and sensitization with the help of prior illumination. F. KAEMPF. *Z. wiss. Photogr.*, **45** (No. 7-9) 165-73 (1950) In German.

The Herschel effect is always accompanied by a normal blackening effect on the emulsion. With AgBr emulsions the Herschel effect is greatly increased by initial bathing of the plate in quinone solution, especially if inorganic salts are added. The limit of the effect is at about 1μ . If the plate is exposed before bathing, the effect disappears but the emulsion is sensitized up to 1μ . S. T. HENDERSON

778.3 : 535.371.07

4987. Luminescence photography. H. H. EMSCHER-MANN AND H. UMSTÄTTER. *Arch. tech. Messen, Issue No. 180* (Ref. V142-13) T3 (Jan., 1951) In German.

An arrangement for recording simultaneously viscometer and clock readings by projection of images on to phosphorescent screens. J. EWLES

778.3 : 539.17

4988. Nuclear multiple plate camera. J. C. ALLRED, L. ROSEN, F. K. TALLMADGE AND J. H. WILLIAMS. *Rev. Sci. Instrum.*, **22**, 191-4 (March, 1951).

A nuclear multiple plate camera has been devised which permits observations to be made on scattering and reaction processes resulting from the bombardment of gas targets with a charged particle beam. Sixty-nine photographic plates are held in a rigid geometry which allows simultaneous measurements of interaction differential cross-sections at 2.5° intervals from 10° to 170° in the laboratory system. Because of the precision with which the camera is machined, relative cross-section measurements can be made essentially within the statistical error of the number of particle tracks counted at each angle. As a check of the apparatus, measurements were made on the p - p and p - He^4 elastic scattering processes. The results are in excellent agreement with previously reported counter data. A.

778.37

4989. Bibliography on high-speed photography. Including Schlieren and cathode-ray oscillograph photography. *J. Soc. Mot. Pict. Televis. Engrs*, **56**, 93-112 (Jan., 1951).

778.37 : 537.228.4

4990. Kerr cell photography of high speed phenomena. E. M. PUGH, R. V. HEINE-GELDERN, S. FONER AND E. C. MUTSCHLER. *J. Appl. Phys.*, **22**, 487-93 (April, 1951).

Visible light photographs have been obtained of metal jets squirted from the lined conical cavities of high explosive charges. Since these jets travel through air at nearly meteoric velocities (7 to 12×10^5 cm/sec), their front ends are heated to incandescence and vaporized. The remainder of the jet is relatively non-luminous and is photographed by synchronizing a Kerr cell shutter (exposure time $< 1\mu\text{sec}$) and an exploding wire light source (peak intensity 4×10^8 candle power) with the phenomenon. Schlieren type photography cannot be used because of the luminosity accompanying the phenomenon. Detail is obtained in the photographs by using a large lens with a 7 in focal length. To maintain the effective aperture at $f/4$ requires a large Kerr cell which is turn requires a $25\,000$ V pulse for its operation. The technique is used in studying the action of these jets on steel, water, glass and Plexiglas. The technique is also used in studying the propagation of shock waves in solids and liquids when these phenomena are due to the action of the metal jets or to the more direct action of explosives. A.

778.37 : 621.383.4

4991. Use of image converter tube for high-speed shutter action. A. W. HOGAN. *Proc. Inst. Radio Engrs*, **39**, 268-70 (March, 1951).

The equipment described provides a means for obtaining high-speed photographs while utilizing a continuous light source. The device may be pulsed once for "one-shot" exposures or repetitively for motion pictures or stroboscope applications. The heart of the equipment is an image converter tube such as the 1P25. Images are impressed on the photocathode and the tube is pulsed electrically for a duration equal to the exposure time desired. The image will then appear on the fluorescent screen and may be viewed directly or photographed. A.

778.4

4992. A high-speed stereoscopic Schlieren system. J. H. HETT. *J. Soc. Mot. Pict. Televis. Engrs*, **56**, 214-18 (Feb., 1951).

A stereoscope Schlieren system is described. A 16 mm Fastax Camera is used to photograph 10 in sections of a 4 by 4 in flame tube at 9 000 frames/sec. A polarizing projection system is used. The depth effect is observed with burning gases provided sufficient detail is available in the image. A.